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24 JUL 1950

C. M. HARDIN, *Director* . . . . . J. G. DUNCAN, *Editor*

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: 1) progress reports on long-term major research projects; 2) final reports on short-term projects and 3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

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ARTIFICIAL INDUCTION OF MAMMARY GROWTH AND LACTATION IN STERILE HEIFERS WITH STILBESTROL-PROGESTERONE IMPLANTATIONS

By JOSEPH MEITES, E. P. REINEKE and C. F. HUFFMAN
DEPARTMENTS OF PHYSIOLOGY AND PHARMACOLOGY AND DAIRY HUSBANDRY

MANY potentially valuable dairy heifers are sold for slaughter each year because of their failure to breed. While research into the causes of sterility in cattle will undoubtedly lead to the correction of reproductive disorders in a large proportion of cases, it is expected that some animals will remain sterile. As a result of investigations of the hormone control of udder growth and lactation during the last two decades, the distinct possibility now exists of realizing the full milk potential of sterile heifers and cows through hormone administration.

The udder of the heifer or cow becomes fully developed during gestation as a result of the combined action of the two ovarian hormones, estrogen and progesterone (8). At about the time of parturition, estrogen is also believed to stimulate the production of the lactogenic or milk-secreting hormone of the anterior pituitary gland, which in turn acts on the mammary tissue to initiate lactation (5, 6).

A potent and inexpensive form of estrogen, diethylstilbestrol, has been used by several investigators for initiating lactation in heifers and cows (1-4, 7, 9). The results have been disappointing from a practical viewpoint because a) the milk yields have been unreliable, ranging from no milk at all to more than 30 pounds daily in a few cases, and b) many of the typical symptoms of nymphomania have usually appeared, including raised tailhead, sunken pelvis bones, a tendency to ride or be ridden by other cows and frequent pelvic fractures. The relatively low milk yields reported in most cases may have been the result of insufficient udder growth, while the nymphomaniac symptoms can be largely attributed to uninhibited estrogen action.

An attempt to avoid the foregoing undesirable effects of estrogen

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alone and more closely duplicate the normal ovarian status during gestation was made by implanting progesterone[1] as well as diethylstilbestrol[2] pellets into two sterile Guernsey heifers, one 2 years old and the other 4 years old. Twenty 100 mg. pellets (2 grams) of diethylstilbestrol were implanted subcutaneously just in front of the left shoulder of each heifer, and forty 100 mg. pellets (4 grams) of progesterone were similarly implanted on the right side of each animal. It was the original intent of this experiment to remove the pellets after 90 days and then start milking.

Up to the present writing, or 114 days after implanting the hormones, the heifers have exhibited no distortion of rump or tailhead, and no gross manifestations of estrous behavior.[3] The absence of the undesirable side-effects of uninhibited estrogen action has been particularly gratifying, although it is possible that the quartering of these animals in stanchions in the experimental dairy barn contributed to their quiet behavior.

The udders of the two heifers at the start and 64 days after implantation of the two hormones can be seen in Figs. 1a and 1b, and 2a and 2b. The udder of the four-year-old heifer (hereafter referred

Fig. 1a. Heifer J-1. Before hormone implantation.

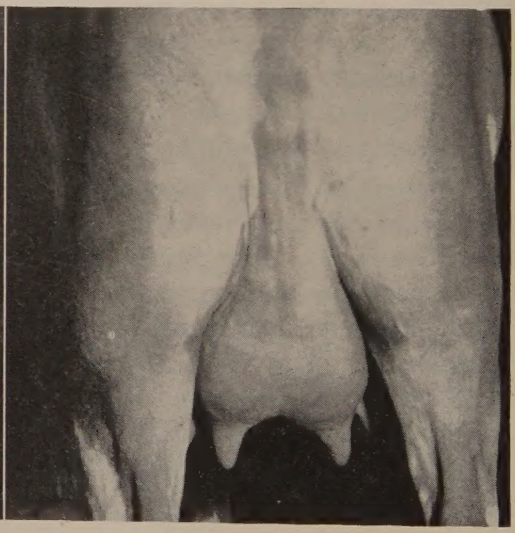

Fig. 1b. Heifer J-1. After 64 days of hormone implantation.

[1]Purchased from the Glidden Corporation, Chicago, Ill.

[2]We are indebted to Dr. D. F. Green of Merck and Company, Inc., Rahway, N. J., for making the diethylstilbestrol available to us.

[3]One of the heifers, J-1, was believed to have come into heat on the 95th day after implantation of the hormones. Findings presented elsewhere in this article indicate that hormone absorption by the circulation from the pellet site had probably ceased before the 95th day, thereby permitting the onset of ovarian function.

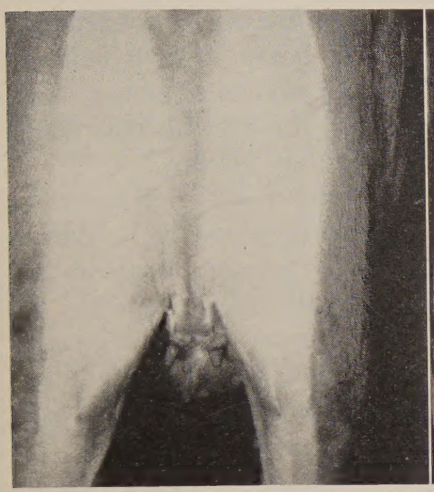

Fig. 2a. Heifer J-2. Before hormone implantation.

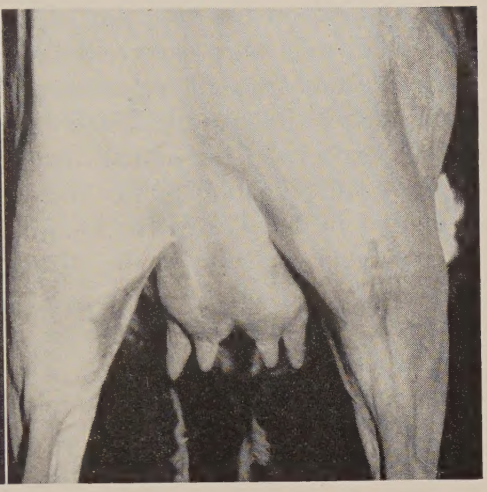

Fig. 2b. Heifer J-2. After 64 days of hormone implantation.

to as J-1) appears larger than that of the two-year-old heifer (J-2) both at the beginning and particularly on the 64th day of hormone implantation. However, the udder of J-1 rapidly began filling with secretion on about the 60th day, while practically no secretion was present in the udder of J-2.

Twice-a-day milking was begun on J-1 on the 64th day of hormone implantation. Her milk and butterfat yields up to the present writing (April 5, 1950) are shown in Table 1. During the first 46 days of lactation, this heifer produced 905.6 pounds of milk and 43.83 pounds of butterfat (average test of 4.84 percent). Her peak yield thus far

TABLE I—*Milk and butterfat production of heifer J-1*

Days	Total 3-day milk yield, in pounds	Average daily milk yield, in pounds	Average 3-day butterfat, in percent
February 16-18	28.1	9.1	5.3
February 19-21	41.2	13.7	5.0
February 22-24	47.8	15.9	4.8
February 25-27	54.5	18.1	4.7
February 28-March 2	57.4	19.1	5.0
March 3-5	60.6	20.2	4.3
March 6-8	61.0	20.3	5.0
March 9-11	61.4	20.4	4.4
March 12-14	64.5	21.5	4.7
March 15-17	63.1	21.0	4.5
March 18-20	72.3	24.1	5.0
March 21-23	69.2	23.0	4.2
March 24-26	76.1	25.3	5.8
March 27-29	72.0	24.0	5.3
March 30-April 1	70.5	23.5	4.7
April 2-4	74.3	24.7	4.2

was attained on the 40th day of lactation, when she produced 35.6 pounds of milk on a 4-percent fat-corrected basis. This is believed to be the highest yield yet attained by any heifer or cow as a result of hormone administration, and compares favorably with that which can be expected from normal first-calf Guernsey heifers.

A rectal palpation of the ovaries and uterus was performed on heifer J-1 by Dr. George R. Moore of the Department of Veterinary Surgery and Medicine on the 102nd day after hormone implantation. The ovaries appeared to be functioning normally, as indicated by the presence of a growing follicle in the right ovary and a regressing corpus luteum in the left ovary. The uterus was normal in size. These observations suggest that the hormone pellets in this animal had been blocked off for some time, thus permitting the onset of lactation. This may also account for the apparent estrus observed in this heifer on the 95th day.

The progesterone pellets in heifer J-2 were removed on the 84th day after implantation, and milking was begun on the 97th day. Only a few milliliters of milk were obtained daily, and it was suspected that this animal was still under considerable hormone stimulation. A rectal palpation by Dr. Moore on the 102nd day revealed the presence of very small, smooth, non-functioning ovaries and a uterus that was at least twice normal in size. These observations indicated that the diethylstilbestrol was still being absorbed into the blood in high concentrations. The diethylstilbestrol pellets were therefore removed on the 104th day of implantation. The average daily milk yield, which was only 0.2 pound on this day, increased to 1.2 pounds three days later, to 2.0 pounds on the 5th day, to 3.9 pounds on the 7th day and to 9.8 pounds on the 10th day after the pellets were removed (up to the present writing). It is expected that this heifer will continue to show a rapid increase in daily milk production.*

It is obvious that several problems remain to be solved before the artificial induction of lactation in sterile heifers and cows by stilbestrol-progesterone treatment can be made practical on a farm basis. Among the most important of these are believed to be a) the determination of the proper proportions of stilbestrol and progesterone to insure optimal udder growth, and b) the finding of improved methods to control the absorption rate by the blood of the two hormones. The present experiment represents only a modest beginning in an attempt to solve these problems.

*When the proof was received for this manuscript (April 27, 1950), the average milk production of heifer J-2 had increased to more than 22 pounds daily.

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WEIGHT CHANGES IN PACKAGED ICE CREAM AT CABINET TEMPERATURES

By JOSEPH A. MEISER, JR.
SECTION OF DAIRY

FOR MANY YEARS it has been known that certain packaged food products undergo physical changes during refrigerated storage. Van Slyke (1901) presented data indicating that unparaffined cheddar cheese placed in 60° F. storage for 15 months at a relative humidity of 75 to 80 percent could lose through evaporation 11.14 percent of its total weight. This loss, as demonstrated by Babcock *et al.* (1903) could be lessened by increasing the relative humidity of the storage room to 100 percent. However, these investigators also found that at a constant humidity the amount of moisture lost from cheese would be greatest at the higher storage temperatures.

Packaged butter as well as cheese will lose weight during storage. Guthrie (1917), (1926) showed that pound prints of butter stored for 155 days at 45° to 50° F. and 0° to 5° F. decreased in weight from 0.134 to 0.204 of an ounce at the higher storage temperatures and 0.101 to 0.120 of an ounce at the lower storage range. Since it was known that certain dairy products lost weight during storage Smith (1935) attempted to apply this physical property to ice cream. With packaged ice cream stored at temperatures ranging from −6° to −20° F., his conclusions were that ice cream did not materially change in weight over periods of 16 to 24 weeks. Because his observations were of a negative nature, the problem was evidently forgotten as no further research relative to ice cream and moisture losses could be found in the literature.

Such was not the case in the cheese industry, as Van Slyke *et al.* (1903) and Lane (1903) used paraffin coatings on experimental cheeses and found this procedure effective in retarding moisture evaporation. Furthermore, Reichart and Downs (1941) investigated

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coatings other than paraffin and found these to be equally as effective as paraffin.

With the approach of World War II food industries, in a renewed effort to preserve food by freezing, turned their attention to improving storage conditions and packaging of their products, a trend which has not subsided today. Hicks (1944), summarizing the demands of the food industry, stated that packaging must prevent leakage or desiccation of the product and the package should be impervious to the transmission of moisture vapors. This, in turn, would prevent changes in weight and also preserve the flavor and appearance of the product. Since it is not known as to what degree ice cream retains its moisture when packaged in the varied type paper cartons used in the ice cream industry today, an investigation was designed that would provide this information.

EXPERIMENTAL

For the following experiments vanilla mixes testing 12 percent fat, 11 percent serum solids and 15 percent sugar were frozen in a Vogt continuous freezer and the resulting ice cream packaged directly from the freezer into pint containers that were previously weighed on a triple-beam, stainless steel balance having a sensitivity of 0.1 gram. All samples were then hardened for 24 hours at $-9°$ F. $\pm$ 1° and prior to being placed in a closed electric cabinet at a temperature of 7° F. $\pm$ 1°, the filled containers were again weighed to obtain the gross weight. This figure less the weight of the unfilled carton was then used in calculating the net weight of ice cream and the percentage overrun. At intervals of one week the containers were removed from the cabinet and reweighed, (the covers remained in place throughout the entire storage period.) Following this procedure the increase or decrease in grams per pint could be tabulated for storage periods ranging from 0 to 24 weeks. Triplicate samples were used throughout the investigation.

RESULTS

It is quite evident from Fig. 1 that ice cream packaged and stored in untreated paper containers loses weight at cabinet temperatures. At the end of 2 weeks' storage the loss for six samples averaged 1.3 grams which may seem unimportant; however, since this decrease occurred primarily at the surface of the product, the loss is highly significant. Continued storage of the ice cream for 24 weeks resulted

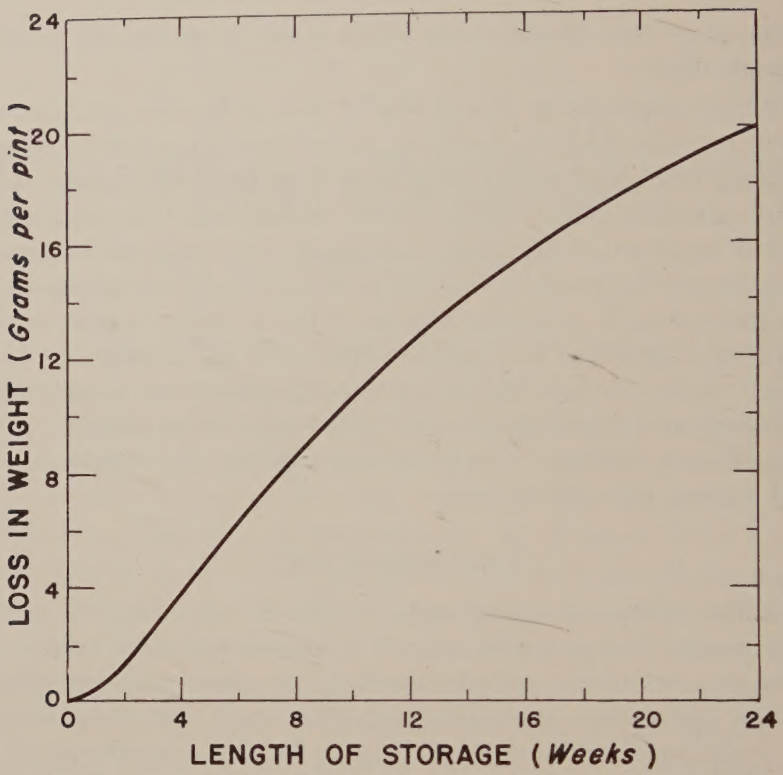
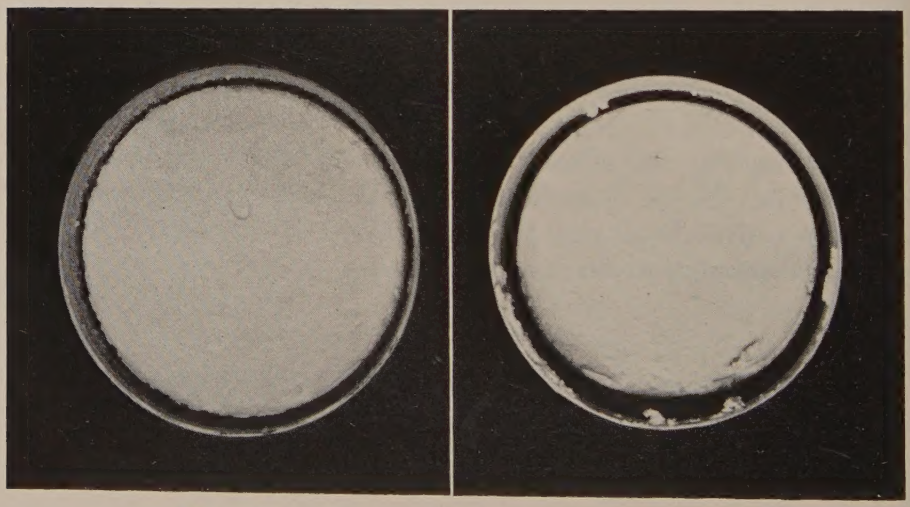


Fig. 1. Effect of length of storage on weight losses of ice cream packaged in untreated cylindrical pint containers at cabinet temperatures.



12 weeks 24 weeks

Fig. 2. Ice cream stored in untreated containers at cabinet temperatures for prolonged periods.

in an average loss in weight of 20 grams per pint and an average decrease in volume of 150 ml. per pint. The physical effect of dehydration on the product appears in Fig. 2 which represents samples taken from the cabinet at the end of 12 and 24 weeks.

The first evidence of settling and separation of the ice cream from the container wall appeared at the end of 8 weeks' storage. Also, the product exhibited a tough leathery surface film of approximately 1 mm. in depth, indicating that dehydration was greatest at the surface. Defects of this nature not only destroy the inviting appearance of packaged ice cream but make the product highly unpalatable as well.

During the early part of this investigation there appeared considerable variation between individual samples. This was found to be due to the position that the sample occupied in the cabinet. Figure

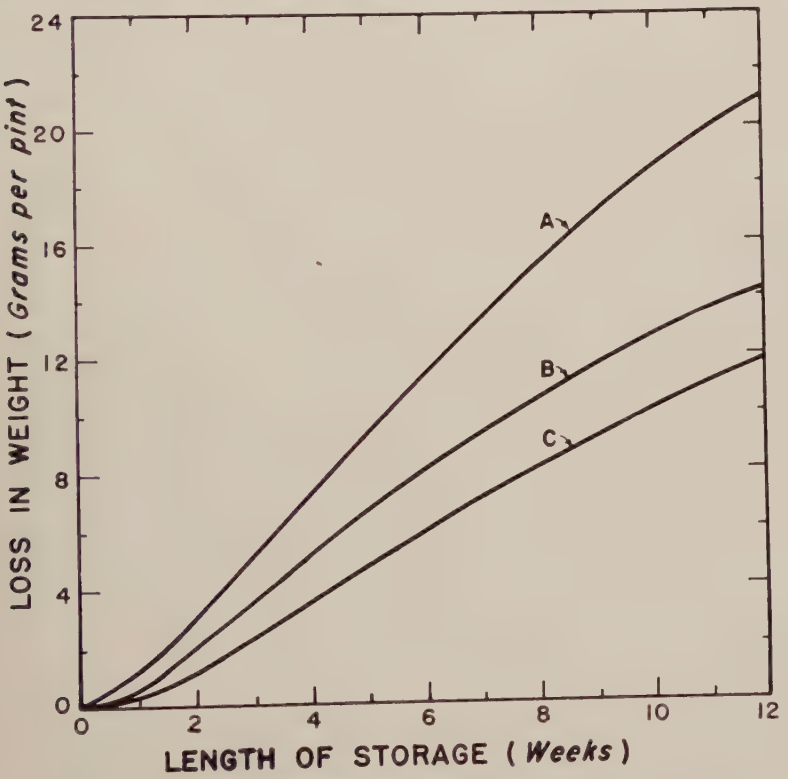


Fig. 3. Effect of distance from the cabinet wall on weight losses of ice cream packaged in untreated cylindrical pint containers at cabinet temperatures. A—Samples placed 4 inches from the cabinet wall. B—Samples placed 2 inches from the cabinet wall. C—Samples placed against the cabinet wall.

3 shows that samples placed nearest the cabinet wall exhibited the smallest change in weight; whereas, samples placed one container width from the cold wall showed the greatest change. A check of the air temperature in the center of the cabinet showed that a temperature of 7° F. ± 1° was being maintained provided the lids of the cabinet were not open for prolonged periods of time. Further checks as to the temperature of the ice cream showed that samples placed adjacent to the cabinet wall were always two degrees colder than those stored one container width away. As a result, all containers under study were placed in the same relative position to the cabinet wall even though this procedure did not allow an economical utilization of storage facilities.

Overrun and weight losses in ice cream appear to be closely related. Figure 4 indicates that if the holding periods exceed 2 weeks, ice cream at 90 percent overrun loses more weight than the same mix

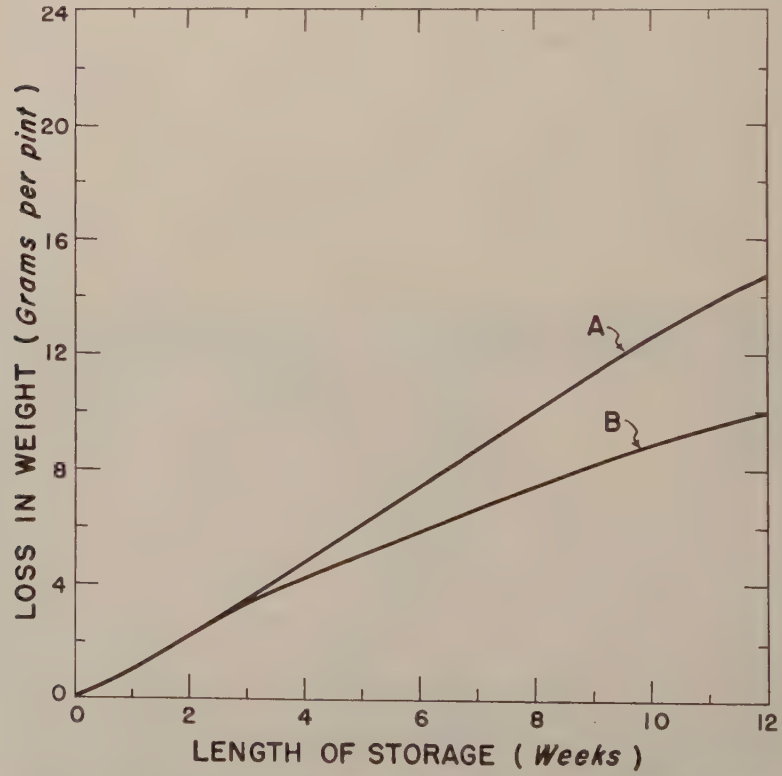


Fig. 4. Effect of overrun on weight losses of ice cream packaged in untreated cylindrical pint containers at cabinet temperatures. A—90 percent overrun. B—120 percent overrun.

frozen to 120 percent overrun. Since the total amount of moisture available for evaporation depends not only on the composition of the mix but on the percentage overrun as well, low-overrun ice cream which contains the greater percentage of water should be affected most.

The dairy industry markets its packaged ice cream in either cylindrical or rectangular paper cartons. Cylindrical containers with tapered sides, termed nestyle by the industry, are also widely used.

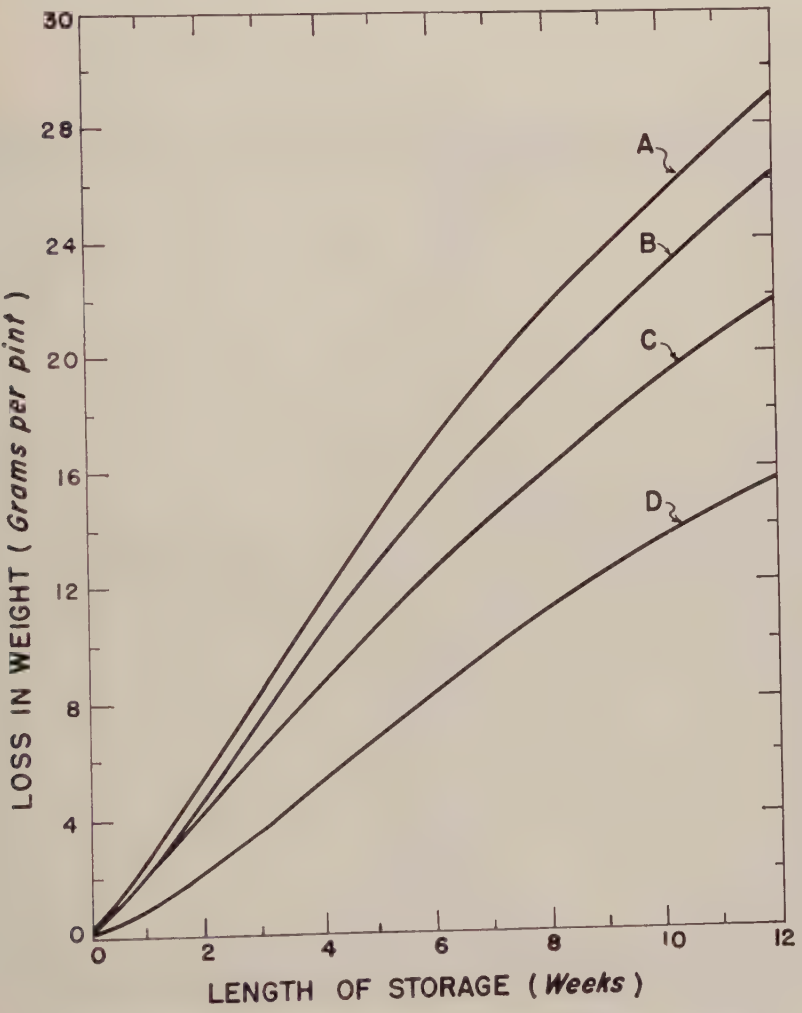


Fig. 5. Effect of container design on weight losses of ice cream at cabinet temperatures. A—Squat nestyle. B—Tall nestyle. C—Rectangular pail. D—Cylindrical.

Since the manufacture of packages is not confined to one company, cartons differ in thickness and porosity of the paper board and type of closure. Thus, it is understandable that all containers do not resist moisture transfer to the same degree. For the following experiment four distinct types of paper cartons were used: cylindrical, rectangular pail, tall nestyle, and squat nestyle. The ability of each container under study to resist weight losses is plotted in Fig. 5. Photographs of the physical appearance of the ice cream after 12 weeks' storage appear in Fig. 6.

The superiority of cylindrical containers in this experiment may be due to thickness of the paper used in their manufacture. Unfilled

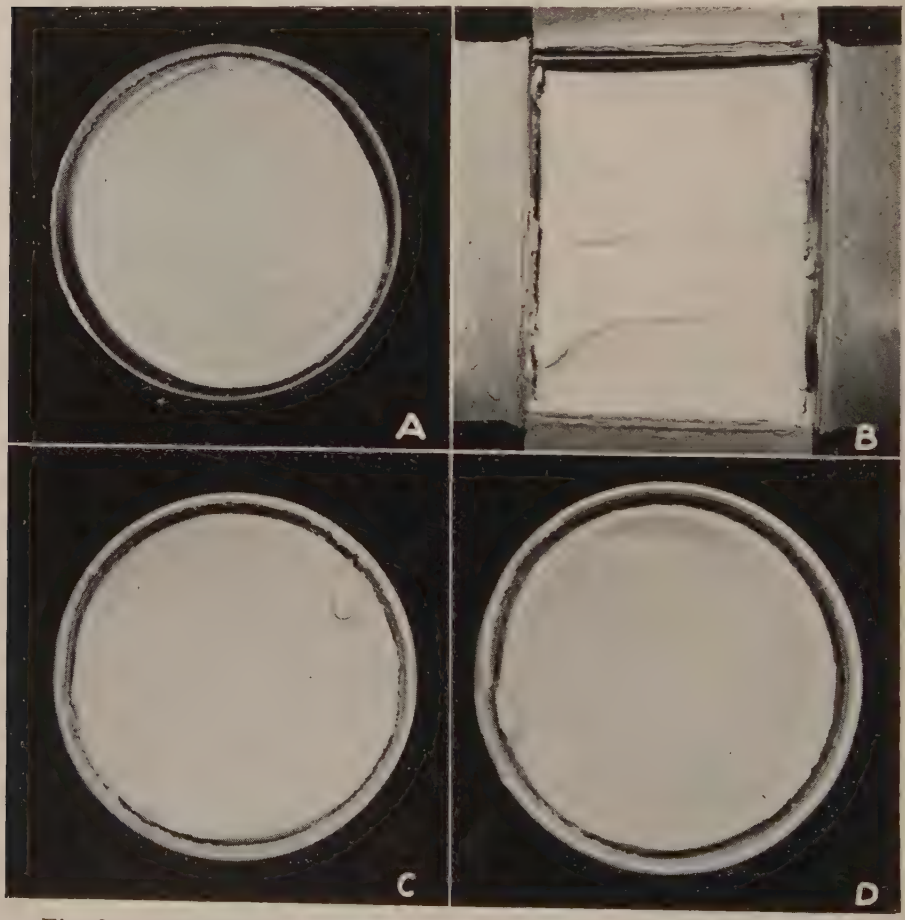


Fig. 6. Ice cream stored in untreated containers at cabinet temperatures for 12 weeks. A—Cylindrical. B—Rectangular pail. C—Tall nestyle. D—Squat nestyle.

cylindrical containers averaged 33 grams in weight; whereas, unfilled nestyles averaged 25 grams. Although no satisfactory method for determining the porosity of these papers could be found in the literature, this factor must not be overlooked as a possible explanation for the differences obtained. The apparent superiority of tall nestyles over squat nestyles may be explained from a surface area standpoint. Although constructed of the same weight paper as the tall nestyle, the squat nestyle which lost the most weight possessed the greater surface area.

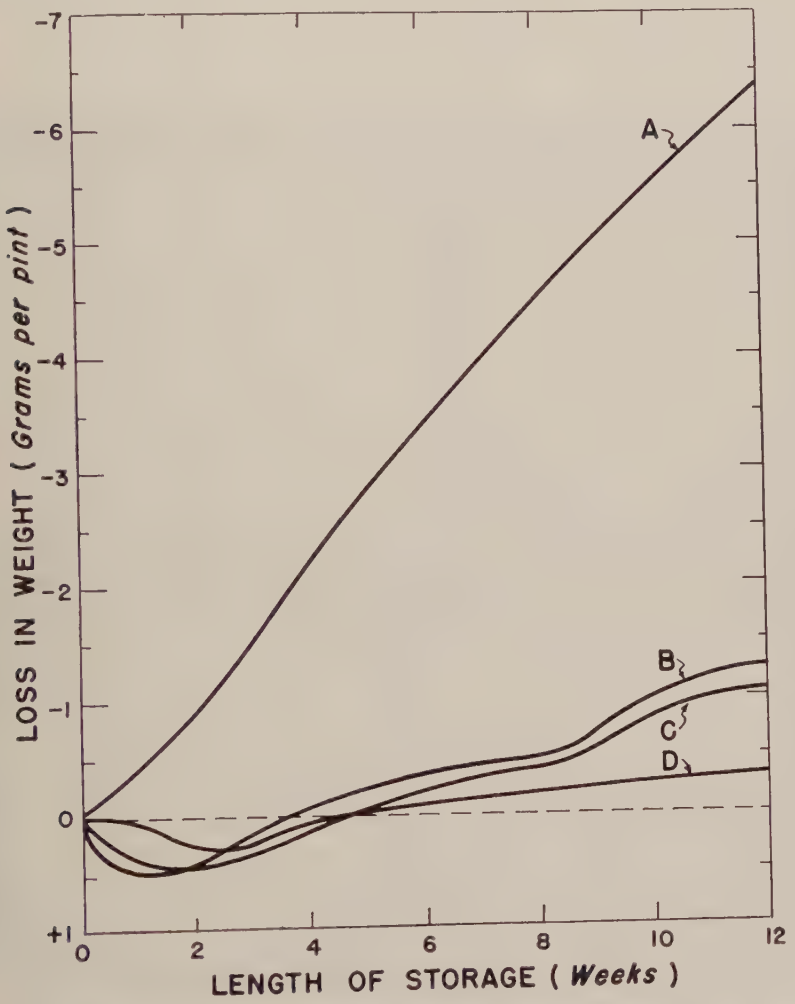


Fig. 7. Effect of paraffin in retarding weight losses of pint ice cream containers at cabinet temperatures. A—Rectangular pail. B—Squat nestyle. C—Tall nestyle. D—Cylindrical.

Of the treated containers appearing on the market, paraffin coated containers are perhaps the most widely used although many ice cream manufacturers have failed to adopt this carton due to its increased cost. Paraffin as shown by Van Slyke (1903) retards weight losses in cheese; therefore, it should exert a similar effect on packaged ice cream. In Fig. 7 are plotted the weight losses of ice cream packaged in four styles of paraffined cartons; whereas, Fig. 8 is a series of photographs taken of the ice cream after 12 weeks' storage. These cartons, appearing in Fig. 8, with the exception of Sample A, were prepared by the manufacturer and all but Sample B were heavily paraffined on the inner and outer surface.

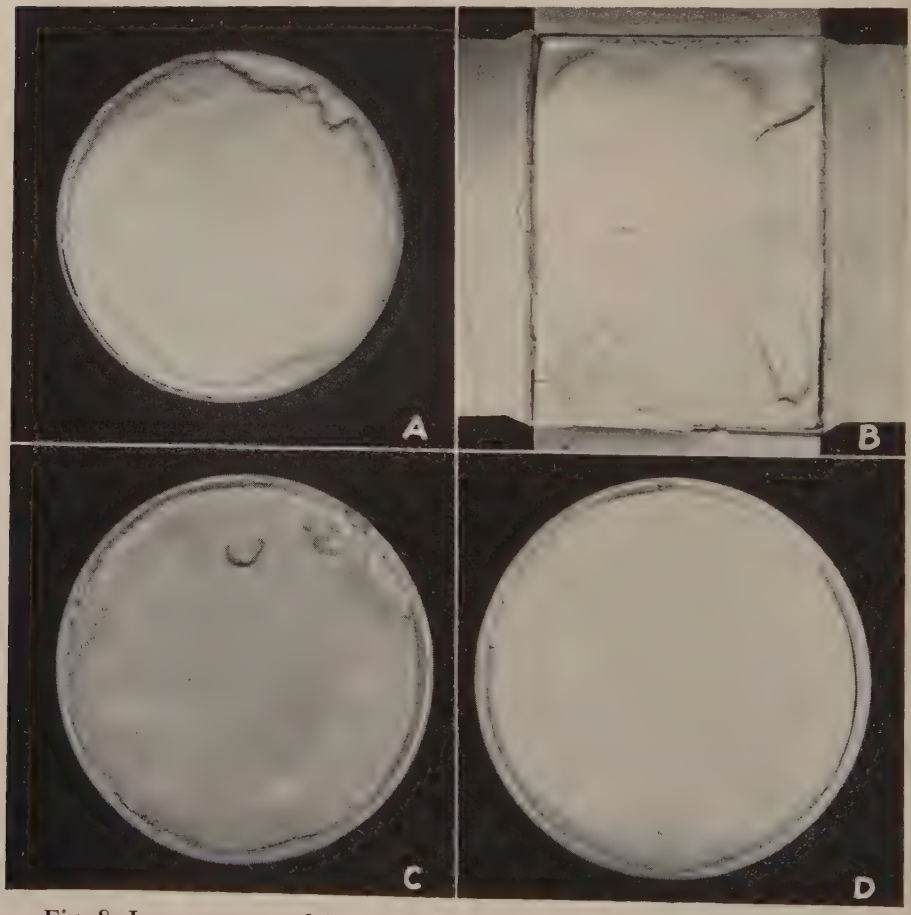


Fig. 8. Ice cream stored in paraffined containers at cabinet temperatures for 12 weeks. A—Cylindrical. B—Rectangular pail. C—Tall nestyle. D—Squat nestyle.

Application of paraffin to the containers greatly retarded weight changes of the packaged product, for at the end of 12 weeks' storage, three of the samples had lost less than 2 grams of moisture. This figure compared to an average loss of 2 grams in one week's time for untreated containers, Fig. 5, demonstrates the importance of protective coatings. As might be theorized, all paraffin coatings are not

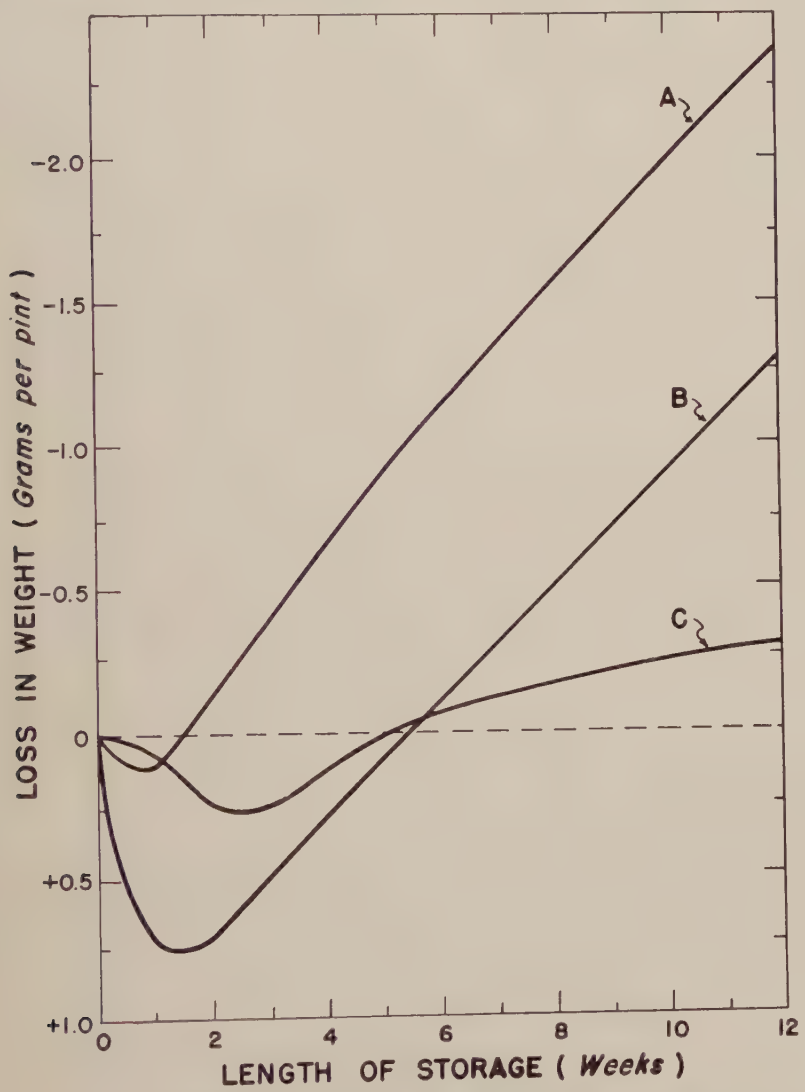


Fig. 9. Effect of position of paraffining on weight losses of cylindrical pint containers of ice cream at cabinet temperatures. A—Paraffined outside. B—Paraffined inside. C—Paraffined inside and outside.

equally effective. Sample B which was not heavily treated lost 6 grams of moisture in 2 weeks; however, that was a pronounced improvement over its untreated counterpart.

All containers in Fig. 7 were paraffined on the inner and outer surface. However, it is possible to fabricate packages paraffined on one side only. What effect the position of the coating has on retarding weight changes is shown in Fig. 9. Although paraffining the inner surface, sample B, was superior to paraffining the outer surface, sample A, neither treatment produced results comparable to paraffining both surfaces of the container, sample C. The superiority of inner coatings to outer coatings may have been due to the pronounced increase in weight during the first 2 weeks of storage, for after the initial 2-week period the rate of loss was roughly parallel in the two samples.

An interesting characteristic of packages appearing in Figs. 7 and 8 is that treated containers have the ability to gain as well as lose weight. This initial gain is due to absorption of moisture from the air as shown in Fig. 10 which records the results of placing unfilled pint containers in the cabinet for a 2-week period. Evidently, the unsatu-

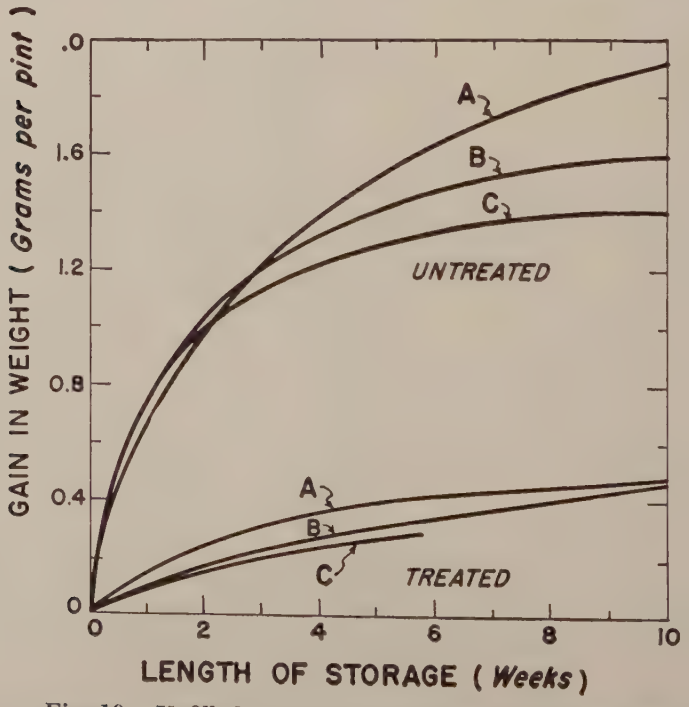


Fig. 10. Unfilled pint containers placed at cabinet temperatures. A—Cylindrical. B—Tall nestyle. C—Squat nestyle.

rated paper takes on moisture from the air in the case of empty containers and from the ice cream as well in the case of filled containers. If the initial increase is due to a saturation of the paper from the air, an increase in total weight occurs. However, if the initial gain is due to saturation of the board from the ice cream, a decrease in total weight occurs. Following saturation of the paper a bleeding of moisture from the partially frozen product through the paper to the less dense atmosphere causes the total weight to decrease.

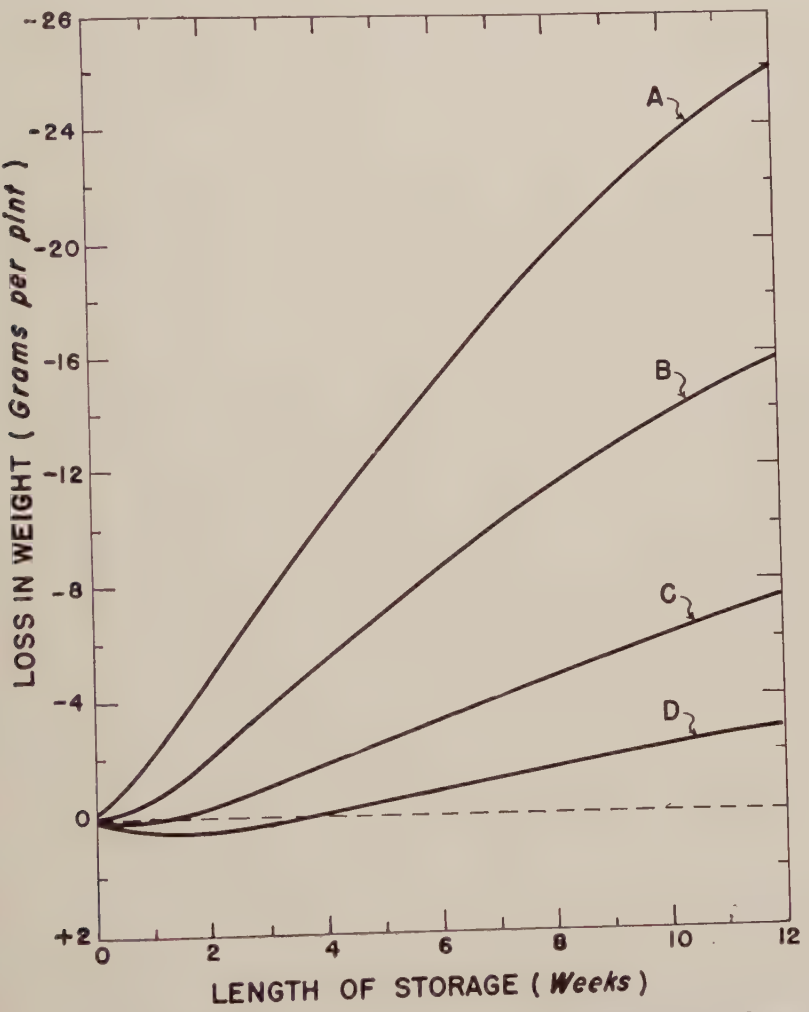


Fig. 11. Effect of vinylite and glassine in retarding weight losses of ice cream. A—Tall nestyle, untreated. B—Cylindrical, untreated. C—Tall nestyle, vinylite coated. D—Cylindrical, glassine lined.

Coatings other than paraffin have been used in fabricating ice cream cartons. Dahle and Meiser (1947), in their study of ice cream shrinkage, lined paper containers with casein glue, laminated aluminum foil, and pliofilm. Since the containers never were manufactured commercially, they cannot be considered in this study. The Sealright Company, however, has prepared a cylindrical pint container possessing a glassine inner surface and a tall nestyle container coated with a vinylite inner surface. Since both cartons are being used by the ice cream industry at the present time, recognition must be given in this investigation. Figure 11 compares the treated containers with their untreated counterparts. Both vinylite and glassine coatings retarded weight losses in the packaged ice cream but not to the same degree as paraffin. It must be remembered that the foregoing containers possess only an inner surface treatment which may account for the differences noted. Bearing in mind the normal rate of turnover in merchandising ice cream, both containers must be considered vastly superior to the untreated packages.

DISCUSSION

The work of Leighton (1927) and others indicates that ice cream is never completely frozen. It is also known that water, including ice, constantly gives off vapors at all temperatures. With these facts in mind it is possible to theorize that the inner surface of paper containers absorbs moisture from the ice cream. Following saturation of the paper, a bleeding of moisture from the product through the paper to the less dense atmosphere proceeds at a fairly uniform rate with corresponding reductions in the weight of the packaged product. If dehydration of the ice cream is permitted for extended periods, the product is altered physically in that a toughened film appears on the surface of the frozen mass. Eventually the ice cream pulls away from the container wall and falls to a lower level; thus severely dehydrated samples possess a shrunken appearance.

Since weight losses in ice cream progress as the length of storage increases, rapid turnover in merchandizing the product is advisable. However, in the event of slow-moving flavors other methods of retarding dehydration must be found, such as improved storage facilities and improved packaging. Improved storage facilities suggests storage of ice cream at uniformly low temperatures free of air currents in the case of open cabinets. In the case of closed cabinets lids must remain in place except for dispensing purposes.

Since the manufacturer has little control over the above-mentioned items, his only hope of overcoming this problem is to choose containers that will resist desiccation of the product. Cartons most capable of meeting this requirement should be constructed of heavy weight paper and designed with a minimum surface area. Lids as well as container bodies should be impervious to moisture. Treatments capable of meeting this requirement include paraffining and the use of certain synthetic coatings such as glassine and vinylite. In the case of paraffin, containers should be coated on both the inner and outer surface.

Cartons possessing the foregoing features not only prevented desiccation of the product but maintained the natural appearance of the ice cream for longer periods.

SUMMARY

Ice cream packaged in untreated paper containers loses weight on continued storage at cabinet temperatures. These losses produce a toughening of the ice cream surface and eventually cause the product to pull away from the container wall and fall to a lower level.

Of the untreated cartons studied, those containers constructed of the heaviest weight paper and possessing the minimum surface area resisted desiccation of ice cream to the greatest degree.

Containers fabricated with an inner coating of paraffin, glassine or vinylite were superior to untreated containers in retarding moisture loss. However, containers paraffined on both the inner and outer surface offered the greatest protection against desiccation.

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EFFECT OF IRRIGATION ON THE YIELD OF SNAP BEANS, SWEET CORN AND TOMATOES AS INFLUENCED BY CERTAIN CULTURAL PRACTICES IN 1949[1]

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STUDIES of the effect of various irrigation practices on the yield of two varieties of snap beans, sweet corn and tomatoes in 1948 (2), indicated that the minimum application of water gave, with the exception of snap beans, the maximum net return and generally the greatest increase in yield over unirrigated comparisons. The influence of irrigation on beans in the 1948 tests was inconclusive. An increase in size of tomatoes and corn and an increase in the percentage of ears that were marketable in corn were also observed in these tests. In order to obtain additional information with reference to the optimum quantity of water to apply and to determine the influence of these practices on such factors as rate of fertilization, plant spacing and variety, the work was continued with some modification on the same field in 1949.

IRRIGATION TREATMENTS

The following conditions were established as criteria for irrigation:

1. Unirrigated.
2. Irrigated with 1 inch of water whenever the available moisture content of the soil dropped below 50 percent as determined by the Bouyoucos (1) gypsum moisture block readings.
3. Irrigation with 1 inch of water whenever the rainfall during the previous 7 days was less than 1 inch.
4. Irrigation with 1½ inches of water whenever the rainfall during the previous 7 days was less than 1 inch.

[1]Acknowledgment is gratefully made to the Michigan Orchard Supply Co. of South Haven, Michigan, for their cooperation in furnishing the pumping equipment and portable pipe used in the studies.

ARTICLE 32-55

5. Irrigation with 2 inches of water whenever the rainfall during the previous 2 weeks was less than 2 inches.

The water used for irrigation was pumped through quick-coupling portable pipe from an adjacent stream and distributed to the plots through rotary sprinklers. Owing to a spring drought, in order to make planting feasible, it was necessary to apply on May 31 approximately 1 inch of water to the entire area.

CROPS AND CULTURAL PRACTICES

Crops	Snap Beans	Sweet Corn	Tomatoes
Number of plots	60	60	90
Size of plot	252 sq. ft.	252 sq. ft.	160 sq. ft.
Variety	1. Tenderlong 2. Pure Gold	1. Golden Cross Bantam	1. Stokesdale
Date planted	June 3	June 1	June 1
Harvest period	July 28-Sept. 3	Aug. 15 and 23	Aug. 6-Oct. 7
Fertilizer treatment: (pounds to the acre)			
"Normal"	500—3-12-12	500—3-12-12	1000—3-12-12
"Heavy": As above plus the following, applied as side dressing July 2:			
	500—3-12-12 50 ammonium nitrate	500—3-12-12 150 ammonium nitrate	500—3-12-12 100 ammonium nitrate

In addition to the factors considered above, sweet corn was planted at both an 8- and 12-inch spacing in rows spaced 3 feet apart. Tomato plants were set without starter solution, with starter solution, and after the washed roots of the plants had been dipped in dry powdered bone char[2].

Each crop was planted in three separate blocks, each being a complete replicate. The various treatments were randomized in blocks of irrigation treatments which were in turn randomized in each of the three blocks.

TABLE 1—*Recorded rainfall on irrigation test plots (in inches)*

	30-year average	1948	1949
May 15-31	1.71	.66	1.91
June 1-30	3.51	3.94	6.74
July 1-31	3.10	1.91	2.68
August 1-31	2.82	1.00	4.21
September 1-15	1.46	1.77	1.41
Total	12.60	9.28	16.95

[2]A spent adsorbent material used in the refining of cane sugar and corn syrup.

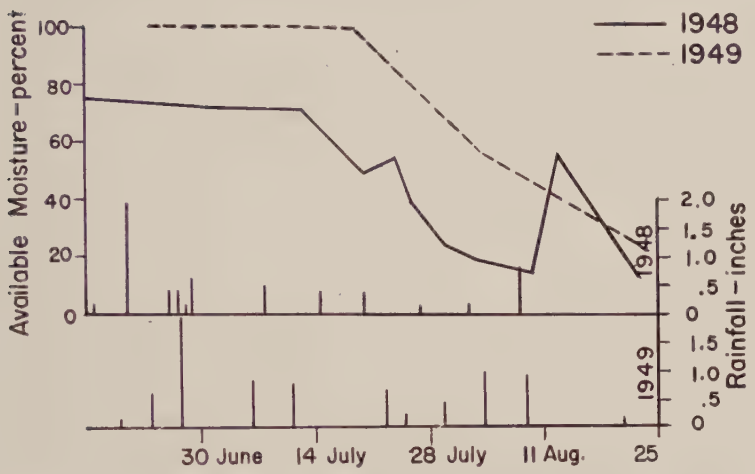

Fig. 1. Seasonal rainfall and soil moisture levels in unirrigated snap beans.

COMPARATIVE RAINFALL AND SOIL MOISTURE CONDITIONS

Table 1 shows the average rainfall from May 15 to September 15 for a 30-year period for East Lansing, Michigan, and the actual precipitation for the years 1948 and 1949 on the irrigation plots located 6 miles from East Lansing. The figures show that the 1948 rainfall of 9.28 inches was 26 percent below the 30-year average and that the 1949 rainfall of 16.95 inches was 34 percent above the average.

Figures 1, 2 and 3 show the distribution of rainfall in both years and also the quantities of available moisture estimated from an average of two moisture block readings taken at 4-inch and 8-inch depths in each of the unirrigated replicates during the two seasons.

The average percentage of the total possible available water for the crop season as measured by the blocks for both years with the three crops in the unirrigated plots is shown by the data below.

Crop	1949 Mean	1948 Mean	Difference
Snap bean	76%	49%	27
Sweet corn	78	50	28
Tomato	84	47	37
Average	79	49	30

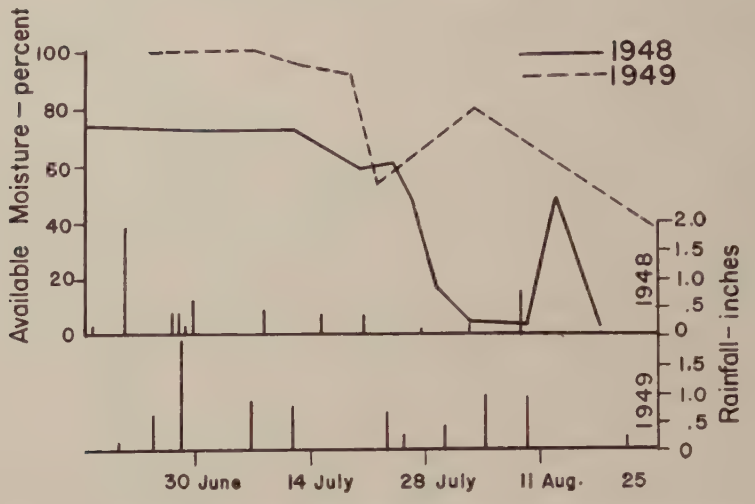

Fig. 2. Seasonal rainfall and soil moisture levels in unirrigated sweet corn.

These values are indicative of the actual moisture condition that prevailed if the blocks, from which the readings were taken, reflect the actual moisture availability in the soils on which the crops were growing. The calculated mean moisture values with tomato include an additional month, which is reflected in the difference in the values obtained. Based on these block readings, it appears that there were

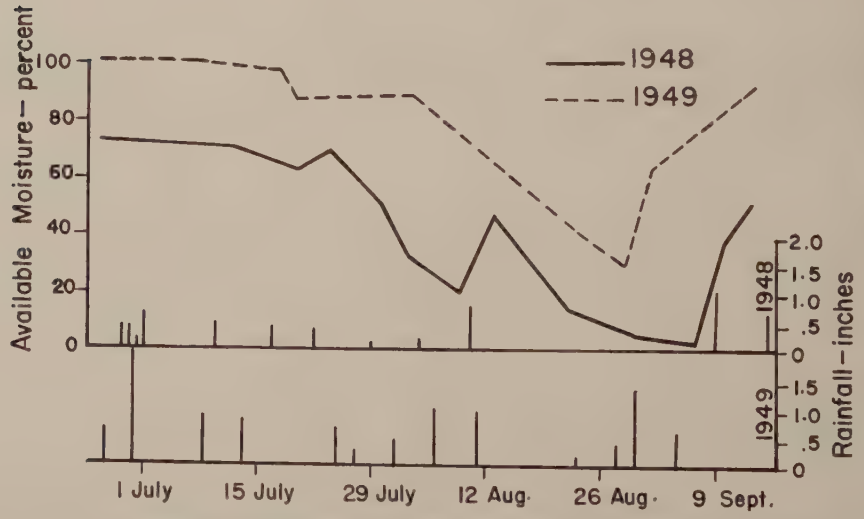

Fig. 3. Seasonal rainfall and soil moisture levels in unirrigated tomatoes.

no great differences among the moisture contents of the soils in which these three crops were growing. However, in 1949 the seasonal mean average available moisture level in the unirrigated plots was 30 percent higher than in 1948.

In Fig. 3 the graphs indicate that a lack of effective rainfall in 1948 between July 21 and August 11, and again between August 11 and September 9, markedly influenced the available moisture content of the soil on which the tomatoes were growing. In the first period the available moisture dropped from above 60 percent to about 20 percent. In the second period it dropped from approximately 50 percent to less than 5 percent. In contrast, in 1949 only during a short period from August 17 to August 30 did the soil contain less than 50 percent of available moisture. In 1949 the growth in the snap bean and sweet corn crops was practically completed prior to the dry period.

RESULTS AND DISCUSSION

INFLUENCE OF VARIOUS TREATMENTS ON THE YIELD OF SNAP BEANS IN 1949

The average yield of snap beans (Table 2) from the unirrigated plots was not significantly different from the averages of the yields obtained on any of the four irrigated comparisons in 1949. The amount of rainfall, 12 inches during the growing season, and the pattern of its distribution was apparently adequate, on the overall average, to meet the moisture requirements of the bean crops. The average yield from the Pure Gold variety plots was significantly greater than that of the Tenderlong variety. The overall average yields from the plots receiving the 500-pound-to-the-acre fertilizer application were not significantly different from the average yields of the more heavily fertilized plots.

However a difference in variety response to fertilization and irrigation is indicated by the data in Table 2. A comparison of the yield averages for the unirrigated plots of the Tenderlong variety shows an increase of 0.5 ton to the acre for the additional fertilizer application, while in the Pure Gold variety a similar comparison indicates a decrease of 0.94 ton to the acre for the additional fertilizer. However, when corresponding plots were irrigated with 4 inches of water, heavy fertilization increased the yield of Tenderlong from 4.06 to 5.18 tons to the acre, but also increased the yield of Pure Gold significantly from 4.91 to 6.08 tons to the acre. A comparison on the basis of irrigation on plots fertilized at the lower rate indicated that with either

TABLE 2—*Influence of irrigation, variety and rate of fertilization on the yield of snap beans*
(Tons to the acre, averages of three plots)

Irrigation practice	Total water applied*	Tenderlong			Pure Gold			Averages		
		Fertilizer rate		Average	Fertilizer rate		Average	Fertilizer		Average
		Normal	Heavy		Normal	Heavy		Normal	High	
	inches									
1. None	0	4.33	4.83	4.58	5.20	4.26	4.53	4.77	4.55	4.65
2. By blocks	1	4.27	4.38	4.33	5.25	4.90	5.08	4.76	4.64	4.70
3. 1″ each week	1	4.67	4.97	4.82	5.42	5.37	5.40	5.05	5.17	5.11
4. 1.5″ each week	1.5	4.51	4.50	4.51	5.05	5.37	5.19	4.78	4.94	4.86
5. 2″ each 2 weeks	4	4.06	5.18	4.62	4.91	6.08	5.00	4.49	5.63	5.05
Average		4.36	4.77	4.57	5.17	5.20	5.19	4.77	4.99	4.88

*Twelve inches of rainfall during the growing season.
Differences required for significance:
Between varieties at 1% level: 0.53 ton.
Within fertilizer treatments for either variety at 5% level: 0.55 ton.
Within fertilizer treatments for various irrigation practices at the 5% level: 0.88 ton.
Within fertilizer treatments for various irrigation practices with either variety at the 5% level: 1.23, and at the 1% level: 1.66 tons to the acre.

variety, a seasonal application of 4 inches of irrigation water resulted in a slight decrease in yield when compared with the yields obtained from the unirrigated plots However, in Tenderlong the yield was increased 0.35 ton and in Pure Gold 1.82 tons to the acre on plots fertilized at the higher rate that had received 4 inches of water.

From averages of the yields of the two varieties, the figures in Table 2 indicate a tendency for yields to decrease with increased irrigation on the plots fertilized at the lower rate and a tendency for the yields to increase with increased irrigation on plots fertilized at the higher rate of application. For example, at the highest rate of irrigation the yield with normal fertilization was 4.49 tons to the acre while with the heavier fertilization the yield was increased significantly by 1.14 tons to 5.63 tons to the acre. As these results are reported for only one type of soil, both the rate and analysis of fertilizer that would be optimum in connection with irrigating beans would not only have to be determined for the variety but also adjusted for the degree of fertility and type of soil.

INFLUENCE OF TREATMENT ON YIELD OF SWEET CORN IN 1949

The graph for available moisture from the unirrigated sweet corn plots indicates that at no time during the growth of the crop in 1949 did the moisture content fall as low as 50 percent of the available moisture capacity of the soil. The soil was irrigated on all plots before the corn was planted on June 1, which promoted a uniform high germination. The data in Table 3 indicates that the increase in yield was less than 10 percent for any irrigation treatment. Five inches of irrigation water did not cause a decrease in yield on plots fertilized at the normal rate nor a significant increase on plots fertilized at the heavier rate.

With a broadcast fertilizer application of 500 pounds to the acre of 3-12-12 fertilizer the average yield on 30 plots was 4.33 tons to the acre, while with the heavier application of 1,000 pounds to the acre of 3-12-12 and a side dressing of ammonium nitrate at the rate of 150 pounds to the acre the average yield was 5.64 tons, or an increase of 1.31 tons. It is possible that the indicated lack of an appreciable response to spacing may be due to the fact that, at the 12-inch spacing in 3-foot rows, more plants produced two marketable ears than at the 8-inch spacing. At the 12-inch spacing heavy fertilization increased the yield significantly by 1.64 tons per acre, while in a similar comparison the increase at the closer spacing was 1.08 tons to the acre.

TABLE 3—*Influence of irrigation, row spacing, and rate of fertilization on the yield of sweet corn*
(Tons to the acre of marketable sweet corn, averages of three plots)

Irrigation practice	Total water applied*	12-inch Row spacing			8-inch Row spacing			Averages		
		Fertilizer rate		Average	Fertilizer rate		Average	Fertilizer rate		Average
		Normal	Heavy		Normal	Heavy		Normal	Heavy	
	inches									
1. None	0	3.97	4.99	4.48	4.80	5.68	5.24	4.38	5.33	4.99
2. By blocks	0	3.85	5.71	4.78	4.32	5.08	4.70	4.08	5.39	4.76
3. 1″ each week	1	4.46	5.83	5.14	4.74	6.42	5.58	4.60	6.12	5.36
4. 1.5″ each week	1½	4.22	5.68	4.95	4.00	5.05	4.52	4.11	5.36	4.76
5. 2″ each 2 weeks	5	4.30	6.12	5.21	4.75	5.89	5.32	4.52	6.00	5.27
Average		4.16	5.80	4.91	4.52	5.60	5.07	4.33	5.64	5.03

*Ten inches of rainfall during the growing season.
Difference required for significance:
Between fertilizers rates at the 5% level: 1.14 tons.
Within fertilizer treatments at either spacing at the 5% level: 1.62 tons.

INFLUENCE OF TREATMENT ON TOMATO YIELDS IN 1949

Methods and Materials—Tomato plants for these tests were grown in flats in cold frames from seedlings started in the greenhouse. At time of planting, June 1, the plants were 6 to 8 inches tall, in an average hardened condition, and showed no blossoms. Each of the five irrigation treatments in each of the three blocks was divided in half by the "normal" and "heavy" fertilizer rates. The fertilizer was broadcast deeply by means of a grain drill. The tomato plots were then irrigated uniformly with 1 inch of water.

The roots of the plants were washed free of soil, and divided into three groups for planting into the two sub-plots of the main irrigation treatments. One-third of the plants were set, using approximately one-half pint of a starter solution formulated by adding 5 pounds of a mixture of 50-percent mono-potassium-phosphate and 50-percent di-ammonium phosphate to 50 gallons of water. At this rate of application, the square foot area in the center of which the plant was set contained a concentration of fertilizer, calculated on an acre basis, of 29 pounds of N, 144 pounds of P_2O_5 and 47 pounds K_2O. A second third was planted with a like quantity of water, and the wet roots of the remaining third were dipped in spent bone-char and likewise given a half-pint of water when planted.

The bone-char treatment was included for two reasons. Previous unpublished data indicated that tomato plants so treated were not affected adversely by a preplanting application of 2,4-D at an effective rate for weed control. Information with respect to a possible detrimental influence of this root treatment on growth and yield in areas not treated with 2,4-D was desirable. In addition the material contained considerable quantities of phosphorus and some organic materials that it had adsorbed during the time it was being used for the clarification of cane and corn syrup. Preliminary observation had indicated that treated plants had a darker green color; therefore, a check on possible benefits from a spent bone-char root treatment was of interest.

Results and Discussion—The results of the above treatments in relation to the five irrigation practices are shown by the figures in Table 4 in terms of early and total yields. The available moisture content on the unirrigated tomato plots did not fall below 50 percent until after August 20, as noted in Fig. 3, and as the third picking was made on August 24, little increase in early yield from irrigation would be

TABLE 4—*Influence of irrigation, plant treatment and rate of fertilization on the yield of tomatoes*
(Tons to the acre of marketable fruit, averages of three plots)

Irrigation practice	Total water applied*	Untreated			Starter solution			Roots in bone char			Averages		
		Fertilizer rate		Ave.	Fertilizer rate		Ave.	Fertilizer rate		Ave.	Fertilizer rate		Ave.
		Normal	Heavy		Normal	Heavy		Normal	Heavy		Normal	Heavy	
A. Early Yields—First Three Harvests													
	inches												
1. None	0	1.60	2.57	2.08	2.81	3.30	3.05	1.86	1.79	1.82	2.09	2.55	2.32
2. By blocks	1	2.29	1.72	2.00	3.48	4.29	3.88	2.08	2.12	2.10	2.61	2.71	2.66
3. 1″ each week	2	2.20	3.02	2.61	3.56	3.60	3.58	1.67	2.72	2.19	2.47	3.11	2.79
4. 1.5″ each week	3	1.79	1.98	1.88	2.82	4.75	3.78	2.06	2.55	2.30	2.22	3.09	2.65
5. 2″ each 2 weeks	2	1.74	2.36	2.05	4.20	3.83	4.01	1.81	2.97	2.39	2.58	3.05	2.81
Averages		1.92	2.33	2.12	3.37	3.95	3.66	1.89	2.43	2.16	2.39	2.90	2.64

*Fourteen inches of rainfall up to the third picking on August 24.

Difference required for significance:	1% level	5% level
Between fertilizer treatments:	....	0.48 ton
Between transplanting treatments:	0.89 ton	0.66 ton

B. Total Yields

1. None	0	16.4	21.1	18.7	17.5	22.4	19.9	16.2	19.4	17.8	16.7	20.9	18.8
2. By blocks	2	16.8	18.3	17.5	16.6	21.2	18.9	15.1	18.1	16.6	16.1	19.2	17.6
3. 1″ each week	4	21.0	19.8	20.4	18.7	20.3	19.5	20.8	21.2	21.0	20.1	20.6	20.3
4. 1.5″ each week	6	16.9	21.6	19.2	15.3	21.2	18.2	14.3	23.2	18.7	15.3	22.0	18.6
5. 2″ each 2 weeks	4.4	18.1	22.1	20.1	20.7	24.0	22.3	16.7	24.8	20.7	18.5	23.6	21.0
Averages		17.8	20.3	19.1	17.7	21.8	19.7	16.6	21.3	18.9	17.3	21.1	19.2

*Eighteen inches of rainfall through the entire season ending October 7.

Difference required for significance at:	1% level	5% level
Between fertilizer treatments:	2.95 tons	....
Within fertilizer treatment for plant treatments:	....	2.60 tons
Within fertilizer treatment for irrigation practices:	5.90 tons	4.40 tons
Within fertilizer treatment for various irrigation practices with any transplanting treatment:	....	7.6 tons

expected. The data indicate that irrigation treatment increases the yield by only 0.33 to 0.47 ton to the acre.

The use of the starter solution, on an overall average, significantly increased early yield over that picked from either the untreated or the bone-char treated plots. The increase in yield for the starter solution, of 1.54 tons to the acre, is of economic significance to both fresh market and canning tomato growers. Starter solution resulted in an increase in yield over untreated plots of 1.45 tons to the acre at the normal rate of fertilizer application, and of 1.62 tons to the acre on plots that had received the higher fertilizer application. In this test the initial fertilizer application was drilled into the entire area. If part of the application had been side placed, it is possible that the large increase in yield from the use of a starter solution would not have occurred. Bone-char-treated plants yielded relatively less than those from comparable plots of untreated and starter solution treated plants in the unirrigated treatment, indicating a possibility of injury from the use of this material.

The heavy rate of fertilization significantly increased the early yield by over 0.5 ton to the acre on plots receiving either starter solution or the bone-char treatment. However, the increase of 0.42 ton for the heavy fertilizer treatment on plots in which the plants had not received either planting treatment was not significant.

Total average yields, Table 4B, were not significantly influenced by any irrigation treatment. Although transplanting treatment significantly increased early yield, the influence of this treatment was not maintained throughout the season as indicated by the small increase in total yield for the use of starter solution over the untreated of only 0.6 ton to the acre. However, the plots on the "heavy" fertilizer treatment, based on an average of 45 plots, out-yielded the plots receiving the "normal" fertilizer treatment significantly, by 3.8 tons to the acre. These results indicate that the starter solution was effective in the early stages of growth, and that as the plant reached maturity and its roots filled a larger soil mass, the effects of a larger broadcast application of fertilizer were required to increase total yield. An initial side-placed application might have had a comparable effect. On either series of plots that received the various transplanting treatments, on an average, the heavier rate of fertilization significantly increased the yield above that obtained on plots that received the smaller quantity of fertilizer. However, heavy fertilization did not signifi-

cantly increase the yield on plots in which the plants received no transplanting treatment.

Without irrigation an increase of only 4.2 tons to the acre was recorded for heavy fertilization; but with the 6-inch irrigation treatment a significant increase in yield from heavy fertilization of 6.7 tons was obtained. This latter increase is due in part to a decrease in yield with normal fertilization on plots receiving 6 inches of water, but also in part to an actual increase at the higher fertilization rate for the 6 inches of irrigation water.

It would appear that the late applications of water, after the available moisture content had dropped below 50 percent, were profitable if the level of nutrients in the soil was adequate to meet plant requirements. An increase in yield for bone-char of 8.6 tons to the acre between the yields for the unirrigated normally fertilized plots and the plots receiving 4.4 inches of water with the heavy fertilizer application is both statistically significant and interesting. The possibility exists that the product may have some value under certain conditions, as the yield of 24.8 tons to the acre was the highest obtained for any treatment. While there was no significant increase on the overall average of all other treatments for irrigation in a season of above-average rainfall, through the interaction of several other practices with irrigation, an increase in the yield of tomatoes of over 50 percent was obtained.

A COMPARISON OF 1948 AND 1949 RESULTS

It was noted earlier that the seasonal soil moisture available to the three crops in 1949 averaged 27 to 37 percent greater than in 1948. The figures in Table 5 indicate, on the basis of the overall averages for the other factors considered, the comparative response to the irrigation practice giving the greatest increase in yield for each of the crops for both years. The increases in yield for irrigation in 1949 were not significant. The rainfall for the crop season in 1949 was 7.67 inches more than in 1948, and still in 1948, yields, with the exception of snap beans, were reduced when more than 4 inches were applied (2); in 1949 with 7.67 inches more rainfall than in 1948 no reduction in yield was obtained when 4 or more additional inches were applied.

From the uniformity of the graphical data relating to the percentage of available moisture in the soils on which the three crops were grown it appears that their moisture requirement, at least, in this experiment, based on block measurements, is similar. As the figures in

TABLE 5—*Comparative effects of irrigation in 1948 and 1949 on snap beans, sweet corn and tomatoes*

(Yields in tons to the acre)

	Snap beans		Sweet corn		Tomatoes	
	Water applied	Yield	Water applied	Yield	Water applied	Yield
1948 Results:	inches		inches		inches	
Average for unirrigated	0	2.05	0	2.69	0	15.01
Average for most responsive irrigation practice	15.5	2.92	4	6.07	4	24.99
Percent Increase	.....	43	.....	126	.....	66
1949 Results:						
Average for unirrigated	0	4.65	0	4.99	0	18.8
Average for most responsive irrigation practice	4	5.05	5	5.27	4.4	21.0
Percent increase	.....	9	.....	6	.....	12

Table 5 are averages including several other factors, but not soil type, it might be suggested that for those three crops 4 inches of supplemental irrigation, applied at the proper time, in relation to stage of crop development and rainfall distribution might be adequate in seasons in which the rainfall does not vary more than 25 to 30 percent from the normal. Until work is conducted on many different soil types this suggestion can only be related to soils in the same class as the Hillsdale sandy loam. In addition the fertilizer must be adequate in seasons of above-average rainfall, to maintain satisfactory nutrient condition in the crop, if decreased yields from irrigation are to be avoided.

SUMMARY

The relation of various irrigation practices in conjunction with the effects of several other practices or factors on the yield of snap beans, sweet corn and tomatoes was investigated in 1949 and compared with the results obtained in 1948.

In the 1948 crop season, with a rainfall of 76 percent of the average 30-year value, the application of 4 inches of water increased the yields of these crops from 50 to 125 percent. In 1949 with a seasonal rainfall during the crop season totaling 134 percent of the average, the increase in yield for the use of irrigation on the same crops was not significant, ranging from 6 to 12 percent. However in 1949 when the most productive irrigation practice was combined with higher than normal rates of fertilizer application—even in this wet year—the crop increases ranged from 10 to 20 percent above those of unirrigated comparisons.

In seasons of above-average rainfall, higher rates of fertilization than those normally suggested appear justified. Experimentation in this study with starter-solution-treated tomato transplants indicated that the treatment was significantly effective in improving early yield but not total yield.

From the results to date, under the conditions of this experiment, it appears that approximately 4 inches of irrigation are adequate and productive of yield increases during seasons in which the rainfall varies in either direction as much as 25 percent from the average. When the rainfall is considerably above the average, 34 percent in 1949, it is highly desirable if irrigation operations are to be of any value to adjust the fertilizer application upward, if necessary because of leaching, to assure the maintenance of an adequate nutrient level to meet the requirements of the crop.

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CONTROL OF CRABGRASS (*DIGITARIA SPP.*) BY THE USE OF CHEMICAL SPRAYS[1]

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DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

CRABGRASS has been one of the chief turf weed problems in the eastern states and has become, in recent years, of considerable importance in Michigan and other midwestern states. This has been due, at least in part, to the widespread usage of 2,4-D for the control of dandelion and other broad-leaved weeds. The removal of such weeds often leaves bare spots in turf and in those spots crabgrass often germinates and becomes a well-established weed plant. 2,4-D, as it is usually applied, has but little effect on crabgrass plants that have developed beyond the early seedling stage. Intensive efforts have been made, in the past three years, to discover practical and effective selective chemicals for the control of crabgrass.

DeFrance (1), Wolf and Engle (2), and Grigsby (3) have reported results which indicate that selective control can be obtained with a number of chemicals with widely differing properties. During the summer of 1948 series of experiments were started at East Lansing, and at selected locations in other states, to determine the effectiveness of certain petroleum products in the control of crabgrass. In 1949 comparative studies of petroleum and other chemicals were made at East Lansing. In these latter trials only rough crabgrass, *Digitaria sanguinalis* (L) SCOP., was used as a test plant.

MATERIALS AND METHODS

In the 1948 trials only two products, petroleum fractions supplied by the Standard Oil Company (Indiana) under the laboratory formulation numbers of L-2687 and L-2988, were tested. Each of these products is a petroleum naphtha with a boiling range somewhat higher than the dry-cleaning naphthas and slightly lower than kerosene. Inspection data for both compounds are shown in Table 1.

[1]This research was supported by a grant-in-aid from the Standard Oil Company (Indiana).

ARTICLE 32-56

TABLE 1—*Inspection data on petroleum fractions used as crabgrass sprays*

	L-2687	L-2988*
A.P.I. gravity	45.2	46.1
Distillation, °F.		
Initial	368	366
10 percent at	392	394
50 percent at	420	423
90 percent at	449	454
End point	498	484
Aromatics, percent (ASTM—DH875–46T)	2.7	0.8
Flash point, Cleveland open cup	154	160
Color, Saybolt	24	30

*This formulation was considered as most suitable for crabgrass control and has been designated as "Standard Crabgrass Spray".

These two compounds were applied, without dilution, at rates of one pint, one quart, and two quarts per square rod on lawns infested with crabgrass. Lawn grasses present in the test areas were Kentucky bluegrass, various types of fescue, Bermuda grass, red top and bent grass. Clover and various broad-leaved weeds were present in most of the plots.

In 1949, trials at East Lansing were made with both formulations without dilution and as emulsions with varying amounts of water. The experiment was also expanded to include other herbicides which are toxic to grasses. In these trials the amount of the herbicides used was reduced to a small fraction of the normal dosage and this quantity added to the oil emulsion. This was done in order to determine whether fortification of the oils would improve the crabgrass-killing properties of the spray and whether injury to lawn grasses would occur when the mixtures were applied. The herbicides used were as follows:

ammonium thiocyanate (NHCNS)
dinitro-O-sec-butyl phenol, ammonium salt (DNOSBP)
fortified Stoddard solvent
isopropyl-N-phenyl carbamate (IPC)
pentachlorophenol (PCP, oil)
phenyl mercuric acetate
potassium cyanate (KOCN)
sodium pentachlorophenate (PCP, Na)
sodium trichloroacetate (TCA)
Stoddard solvent

All emulsions contained enough water to make a total spray volume of either 80 or 160 gallons per acre. Spraying was started in the second week of July and continued, at 2-4 week intervals, until the middle of

September. On plots which received oil alone, repeat applications were made 10 days after the original treatment.

The lawn areas sprayed all consisted of a uniform stand of Kentucky bluegrass with occasional bunches of fescue and some white clover. An abundant stand of crabgrass in various stages of development was present in all plots. Excessive drought was not encountered during the course of the trials. Mowing was done, as needed, in the regular lawn maintenance program of the College grounds crews. The plots in all cases were 1 square rod in area.

RESULTS

The results obtained, location and collaborators, in the 1948 experiments, are shown in Table 2. All results are from visual observation, and only estimated percentages of control were obtained in this season. The trials at East Lansing indicated rather soon that the dosage selected was not great enough to secure adequate control, but it was not feasible at that time to change the program of all collaborators. Repeat applications were made at some locations and, in all instances, information with respect to the tolerance of lawn grasses and clover for the oils was obtained. Satisfactory control of

TABLE 2—*Reports of collaborators in 1948 crabgrass spray trials*

Location	Investigators	Estimate of control at 40 gallons per acre	Effect on other grasses
Arizona	Polps and Beal	Growth inhibited but plants not killed	None
Georgia	Robinson and Burton	Crabgrass discolored but not killed	None
Kansas	Foster	Growth stopped, no seeds formed	None
Michigan	Grigsby	Red color and growth inhibited. Repeat application in 10 days gave 95% control	None on bluegrass. Fescue and Bermuda developed red color on leaf tips only
Minnesota	Nylund	Leaves developed red color, made new growth in 20 days	Temporary stunting of bluegrass and fescue
Missouri	Brooks	50% kill but new germination occurred	None
Missouri	Stark Nursery	Regrowth	None
New Jersey	Engle	Red color in 10 days but regrowth, 27% control	None
Ontario, Canada	Nielson	Regrowth in 2 weeks	None
Rhode Island	DeFrance	Fair to good control, especially with added solvent	

TABLE 3—*Chemicals, rates of application, numbers of seed heads per square foot on crabgrass spray plots and effect on perennial grass*

Plot No.	Petroleum formulation	Rate in gal. per acre	Herbicide added		Total volume of emulsion	No. of applications	No. of crabgrass seed heads	Effect on other grass
			Name	Rate				
1	L-2988	40	None	.....	160 gal.	2	78.25	None
2	L-2988	80	None	.....	160 "	2	39.25	None
3	L-2988	120	None	.....	.....	2	1.75	None
4	L-2988	40	DNOSBP	1 lb.	160 "	2	21.00	None
10	L-2988	40	PMA	4 lb.	160 "	1	75.75	Yellow, stunted
11	L-2988	80	Fortified Stoddard	40 gal.	160 "	2	9.50	Severe tip burn
12	L-2988	80	Stoddard	40 "	160 "	2	13.75	Slight tip burn
15	.....	40	PCP, Na	16 lb.	160 "	2	71.50	Tap growth killed
16	.....	80	PCP, Na	16 "	160 "	1	32.75	Tap growth killed
L-1	.....	80	KOCN	10 "	160 "	1	31.25	Severe tip burn
L-2	.....	80	KOCN	20 "	.....	1	5.50	Top growth killed
6	.....	80	ICA	12 "	.....	1	20.75	Yellow color
7	.....	80	ICA	24 "	.....	1	25.25	Yellow color
8	.....	80	IPC	2 "	.....	1	87.00	None
9	.....	80	IPC	4 "	.....	1	16.75	Some yellow color
13	.....	80	NHCNS	10 "	.....	1	49.00	None
14	.....	80	NHCNS	20 "	.....	1	6.75	None
5	L-2687	40	None	.....	.....	1	108.50	None
6	L-2687	80	None	.....	.....	1	19.75	None
7	L-2687	120	None	.....	.....	1	0.00	None
8	L-2687	40	DNOSBP	1 "	.....	1	28.00	None
9	L-2687	80	PMA	4 "	.....	1	33.25	Yellow, stunted
13	L-2687	80	Fortified Stoddard	40 gal.	.....	1	43.75	Tip burn
14	.....	80	Stoddard	40 "	.....	1	97.50	None
17	.....	40	PCP	16 lb.	.....	1	76.00	Top growth killed
Untreated check							124.25	

crabgrass, as expressed by suppression of growth or actual killing, was obtained only at East Lansing, St. Louis, and Topeka.

The effects of oils alone and oils with the addition of other herbicides are shown in Table 3. The data are from counts of seed heads present on crabgrass per square foot in the sprayed plots 4 weeks after the original spray application.

Visual observations of effects on lawn grasses were made at weekly intervals and at the end of the season when fall growth was evident. These visual observations indicated that neither of the petroleum fractions, when used alone, caused any discoloration or killing of bluegrass at rates below 120 gallons per acre. Rates of 180 gallons, however, caused some destruction of perennial grasses. When rates of 40, 80 and 120 gallons per acre were repeated after 10 days, no injury to lawn grasses was observed. These plots, in early October, were free from crabgrass, the bluegrass was thicker, and as much as 2 inches taller than bluegrass in unsprayed plots. This difference in height was noticeable from a considerable distance and the plots appeared to have had a fertilizer application. The apparent rapid growth of peren-

nial grass probably was due to a lack of competition from crabgrass where effective control had been secured.

In addition to these trials, three lawns on privately owned grounds were sprayed with L-2988 alone. In each case control of crabgrass was obtained when the spray was applied as soon as crabgrass seedlings were visible and the treatment repeated in 10 to 20 days if new germination of crabgrass occurred. When spraying was delayed until crabgrass branches were 4-6 inches in length, growth was inhibited by a single spraying. A second application, when crabgrass developed a red or purple coloration, killed these plants and no regrowth or later germination was observed. A similar schedule at Benton Harbor kept the lawn free of crabgrass the entire season.

On another private lawn, a new seeding of fescue was overrun by crabgrass in early August. This lawn was divided into two parts, and one part sprayed with Stoddard solvent at 80 gallons per acre. The other part was sprayed with the same quantity of solvent to which DNOSBP, at the rate of 1 pound per acre, had been added. Two applications, 7 days apart, were made. Each type of spray treatment gave complete destruction of crabgrass. The sparse stand of fescue was burned to some extent, but no plants were killed. Recovery occurred in 2 weeks, and reseeding made it possible to secure a good stand of desirable lawn grasses. Treatments were made before any crabgrass had produced seeds, and no further germination of crabgrass was observed.

DISCUSSION

Research work in other parts of the country has shown that 2,4-D, phenyl mercuric acetate, potassium cyanate, and possibly other chemicals, control crabgrass under some conditions. These materials, however, must be applied when crabgrass seedlings are just emerging from the soil. Older grass plants are more difficult to kill and, when enough of certain chemical compounds to kill crabgrass is applied, serious injury to desirable lawn grasses may occur. Most home owners and lawn maintenance crews are not able to recognize crabgrass in its early stages of development and do not realize that a crabgrass problem is present until the weed grass is already too far advanced to respond to many chemicals. This fact, in conjunction with the possibility of chemical injury to lawn grasses has limited use of the chemical crabgrass killers heretofore available.

The spray program, using either of the two petroleum fractions described in this report, is not limited by the size of crabgrass nor by

the likelihood of lawn grass injury. This program also may be altered in several ways in order to secure the type of control that is desired under varying degrees of crabgrass infestation.

The data show that the best control of crabgrass, and least effect on perennial grasses, is obtained when L-2988 is used. For that reason the Standard Oil Company expects to place this product on the market in Michigan, under the trade name, "Standard Crabgrass Spray", in the 1950 season.

One of the well established principles in lawn or turf management is that a vigorous healthy turf is one of the best control measures for weed plants. This applies to crabgrass as well as to broad-leaved weeds, and efforts to promote the growth of healthy lawn grasses are the starting point in any crabgrass control program. In the event, however, that crabgrass does appear in the lawn other methods must be used and a chemical treatment program may be required.

The use of the petroleum crabgrass spray appears to be entirely feasible here in Michigan and can be started at any season of the year. Experimental data indicate that an application of petroleum spray when crabgrass is first observed followed by a repeat application within 10 days will kill crabgrass. This procedure can be repeated later in the season if watering or natural rainfall causes germination of additional crabgrass seeds. In using this early spray treatment, the oil should be used at the rate of 1-2 quarts per square rod, or ¾ quart per 100 square feet at each time of spraying.

When crabgrass is permitted to reach the flowering stage before treatment more oil and more rapid retreatment will be required. In such cases, two applications of 2-3 quarts per square rod at 10-day intervals will generally prevent seed production and kill the old crabgrass plants. This heavy rate of application should not be repeated in a single growing season. Some temporary stunting of lawn grasses should be expected.

During the summer of 1949 many lawns became so heavily infested with crabgrass that selective control of crabgrass was not possible. Such lawns should be treated to destroy crabgrass quickly, to prevent seeds from getting into the soil, and a new seeding of desirable grasses made. This can be accomplished safely by the use of a petroleum naphtha such as Stoddard solvent. An application of 3-4 quarts of the naphtha per square rod will give a rapid kill of all annual grasses hit by the spray and a second application 7-10 days later will usually destroy the basal portions of crabgrass clumps which may

have been protected by heavy top growth. Reseeding may be done within 24 hours after the second spraying and new grass will fill in the bare spots before other weeds are able to infest the areas.

The information now available should enable one to choose a chemical, or combination of chemicals, which will give practical selective control of crabgrass in turf. Proper maintenance, once this weed grass is controlled, then will prevent further trouble from crabgrass.

SUMMARY

Selective control of crabgrass can be obtained with a number of chemical sprays. Some injury to perennial grasses may follow heavy applications of certain of these chemicals.

A light petroleum fraction is reported as having selective killing action on crabgrass at most stages of growth. This product does not injure most common lawn grasses.

Two or more applications of 2-3 quarts of oil per square rod are suggested as the most satisfactory rate. Heavier applications may cause some injury.

A program for renewing a lawn, utilizing Stoddard solvent as a grass killer, is suggested.

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HOW TO CONTROL UNDESIRABLE TREES AND SHRUBS

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THE PROBLEM of eradicating or controlling stands of trees and shrub growth is found in several areas. Control is very important in the maintenance of power line, telephone, highway and ditch right-of-ways. Permanent pastures also are often reduced in value by the presence of woody plant growth. In forestry practice, it is often necessary to reduce materially the stand of brush during reforestation to encourage the growth of more desirable trees.

A large number of species are involved, most of them deciduous and capable of sprouting vigorously from the stump when cut. This fact influences greatly the control methods to be used. The only really effective control of these species is obtained through the killing of the root system.

The species vary considerably in their ability to invade areas not now occupied. Usually this invasion is slowed considerably by the presence of a heavy grass sod or turf. If on the other hand, the mineral soil is exposed by cultivation, or otherwise, the invasion is speeded up and a dense stand of seedlings will often appear.

The control procedures fall into two classes; mechanical and chemical. The mechanical methods, in turn, are: 1) cutting, 2) burning, 3) disking, plowing, or bulldozing, 4) girdling. All of these methods have been used for some time and need little discussion. However, it should be pointed out that the first two result in heavy sprouting, while the third results in good seedbed conditions for the establishment of another stand of trees and shrubs. Girdling has the disadvantage of being slow, unsightly and suitable only for larger trees. It is readily apparent, nevertheless, that under certain circumstances one or more of those methods may be the most practical to use and, for that reason, they should be considered before turning to other methods.

ARTICLE 32-57

The chemical method of control of woody vegetation has been developed very rapidly in the last few years. The extensive use of chemicals indicates that it is an efficient and practical method of eradicating woody plant growth.

Most of the procedures involve the use of 2,4-D (2,4-dichlorophenoxyacetic acid) or 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). These two substances are used singly, or together, in both oil and water solutions. For the elimination of woody plants, preparations of the various esters of 2,4-D and 2,4,5-T are usually recommended. The amine salt of 2,4-D is sometimes used also, but the sodium salt of 2,4-D is not recommended for this purpose. Recently several products containing esters of 2,4-D and 2,4,5-T were marketed as "brush killers." Under many conditions such combinations are preferred.

The beginner in this field may be confused by the varying directions for the preparation of solutions. Most recommendations for the use of 2,4-D for the control of crop weeds give the number of pounds of acid equivalent to apply per acre. However, for the elimination of woody plants, the amount to apply per acre will vary widely with the amount and size of the brush. Therefore it is better to prepare a solution of a given concentration and apply a sufficient amount to do a thorough job. The concentration of the solution is measured in parts per million (p.p.m.) of actual 2,4-D or 2,4,5-T in the solution. As an aid in determining concentrations, Table 1 lists the common range of products on the market and the quantities necessary for the various concentrations.

For small quantities, 1¼ ounces or 2½ tablespoons of 40 percent acid equivalent product in 1 gallon water or oil gives a solution of 4000 p.p.m.

The amount of 2,4-D or 2,4,5-T product to use in preparing a spray solution can be easily obtained from Table 1. If the percentage of acid equivalent salt in the product (in combination products add

Table 1—*Amount of commercial product needed to obtain a given spray concentration*

Acid equivalent in product (from label)	Pints of product to add to 100 gallons of water or oil			
	1000 p.p.m.	2000 p.p.m.	3000 p.p.m.	4000 p.p.m.
Percent				
10	8	16	24	32
20	4	8	12	16
30	2⅔	5⅓	8	10⅔
40	2	4	6	8
50	1⅗	3⅕	4⅘	6⅖

2,4,-D and 2,4,5-T together) as given on the label falls between two of the percentages given, the correct amount to use for the concentration desired can be obtained by interpolation. The amount of any product to use to obtain a given concentration can also be obtained by use of the following formula:

$$\frac{xy}{z} = \frac{a}{1000000}$$

x = amount of product to use (to be determined)
y = percent acid equivalent of product (obtain from label)
z = unit of volume to be used (number of oz. in gallon or number of pints in 100 gallon)
a = concentration desired in p.p.m.

The concentration to use should vary with the species being treated and other factors. The more susceptible species permit lower concentrations. The use of 2,4,5-T in conjunction with 2,4-D also permits a slight reduction in concentrations. On larger jobs it may be advantageous to make some effort to determine the most efficient concentration since the manufacturer's recommendation may call for more than is necessary in that particular case.

Both 2,4-D and 2,4,5-T are very toxic to some crop plants. Their use is hazardous to nearby fields and gardens, and precautions should be taken to prevent drifting of the spray. The same spray equipment should not be used for disease or insect control since the 2,4-D and 2,4,5-T residue, even after cleaning, may cause damage.

Foliage spraying can be carried on from the time that full leaf size is reached until shortly before frost, with the best results usually being obtained during July. Ordinary knapsack sprayers can be used for this work, but better results will be obtained with sprayers using over 200 pounds pressure. Such sprayers can be equipped with large tanks and mounted on a power wagon or similar vehicle for right-of-way and similar brush work. Sufficient spray must be used to thoroughly wet the foliage, and the amount necessary will depend on the amount of brush growth but will usually be between 100 and 300 gallons per acre. If the brush is dense and over 5 or 6 feet tall, it may be advantageous to use the cut stump spray method described later. For foliage spraying of the more susceptible species, a concentration of around 2000 p.p.m. should be used. Usually not over 4000 p.p.m. is used, even on the more resistant species. Water is the diluent. Some

workers suggest adding a small percentage of diesel oil also, but our experimental results have not shown a definite advantage for this addition.

A complete kill from one foliage spray application should not be expected, but the stand should be greatly reduced and if a more complete kill is desired, a follow-up spray should be done later in the summer or the next year, covering the entire area or making spot treatments as needed. In any case, much less spray solution will be required for the second treatment.

The cost of foliage spray treatments will vary widely with brush conditions, equipment used, and the skill of the operators. Average costs are of little value to the individual, but as a guide it might be mentioned that some contracts for foliage spraying of more or less average stands of brush have been made for about $35 per acre.

The preceding discussion of foliage spraying has not mentioned the use of ammonium sulfamate (ammate) as a spray material. Ammate has been in use longer than 2,4-D and has proven quite effective on many species. The principal disadvantage is its higher cost, from 50 to 100 percent greater than a 2,4-D and 2,4,5-T combination. However, with some of the resistant species such as oak and ash it has, in some instances, given results superior to those obtained with 2,4-D and 2,4,5-T. For use as a foliage spray, it is prepared at a concentration of ¾ to 1 pound per gallon of water and used in quantities necessary to secure a thorough wetting of the foliage. With some brush conditions, ammate may be advisable either as an initial spray or as the second application following a 2,4-D spray.

The cut stump spray method, using 2,4,5-T esters or combination products, has proven more effective on the resistant species, and where these species are predominant stump spraying is advised. It has the additional advantage of creating a better appearing area but is considerably more costly since cutting of the shrubs or trees is required. This method is applicable both to large tree stumps and to brush that has been cut. The cutting operation should leave stumps of sufficient height that they can be easily located when spraying. The top and sides of the stump should be thoroughly wet with an oil solution applied usually with a knapsack sprayer using a nozzle that delivers a coarse spray. A concentration of about 4,000 p.p.m. is usually recommended for this method, using diesel oil as the diluent. 2,4,5-T is superior to 2,4-D for this type of application and the product used

should contain at least a considerable proportion of 2,4,5-T. A second application will sometimes be necessary to treat those stumps missed and the few that may have a few sprouts.

The dormant spraying of shrubs is another method that appears to have good possibilities but is not yet beyond the experimental stages. For those who may wish to try this method, it is suggested that solutions of from 4000 to 8000 p.p.m. of an ester of 2,4,5-T and/or 2,4-D in diesel oil be applied to the stems from the base or ground line to a height of about 3 feet. The treatment should be made during the dormant season and before any sign of growth activity appears in the spring.

The fourth and last method of chemical control is the poisoning of standing trees. This is a method that has been in use several years. Ammate or sodium arsenite are the poisons usually used. The later is the most effective but has the disadvantage of being a deadly poison. Ammate, while not quite so effective, is non-poisonous and is therefore usually preferred. Methods for the use of these poisons have been described in detail by Peevy (3) and Pessin (4). The author (1) has also described a method of poisoning small aspen trees by the use of a phenolic preparation.

A discussion of the subject of chemical control of trees and shrubs would be incomplete without a listing of the more important species and their susceptibility to 2,4-D and 2,4,5-T. It should be pointed out, however, that many factors effect the reaction of the different species and any such listing can only be generally applicable. More detailed information (2) is available for a number of species but an attempt has been made to condense and summarize the list. This table refers primarily to foliage treatments since most of the resistant species can be killed with the cut stump sprays.

TABLE 2—*Reaction of woody species to 2,4-D and 2,4,5-T*

SUSCEPTIBLE	INTERMEDIATE	RESISTANT
Alder	Aspen	Ash
Blackberry (2,4,5-T only)	Dogwood	Basswood
Birch	Elm	Maple
Cherry	Hawthorne	Oak
Elderberry	Hickory	Rose
Hazel	Pine	
Poison Ivy	Box elder	
Willow	Walnut	
Sumac		

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APPRAISAL OF CERTAIN ECONOMIC AND FISCAL ASPECTS OF THE PITTMAN-ROBERTSON LAND PURCHASE PROGRAM IN SOUTHERN MICHIGAN

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Between 1939 and 1950 the Michigan Department of Conservation spent approximately one million dollars in acquiring wildlife restoration and public hunting grounds in 20 southern Michigan counties. Altogether, 80,356 acres, located in 25 separate projects, were acquired for these purposes.[1] Additional lands also were acquired for the 15 public recreational areas located in the southern part of the state.

Of the lands in the state game areas on January 1, 1950, almost 52,000 acres were acquired under the terms of the Federal Aid in Wildlife Restoration Act of 1937 (50 Stat. 917). This law, commonly referred to as the Pittman-Robertson Act, provides that revenue from the federal excise tax on sporting arms and ammunition be made available to the states for various types of game restoration work, including the purchase of lands for this purpose. The additional acreage included within the game areas represents areas acquired with other funds and lands that have tax reverted to the state.

In the period since the war there has been a substantial increase in the funds available under the Pittman-Robertson law for the purchase of additional game lands. In recent months the Conservation Commission has authorized an expanded land acquisition program. Before embarking on this program, however, the Commission first determined that a survey should be made to evaluate the results of

[1]Most of the attention in this report is given to the older established game area projects. The list of these projects includes the Barry County, Dansville, Deford, Erie, Flat River, Fulton, Gourdneck, Gratiot-Saginaw, Gregory, Lapeer, Minden City, Oak Grove, Pointe Moullee, Port Huron, Saginaw Bay, Three Rivers, Tuscola and Vassar projects. Pittman-Robertson funds have been used in acquiring lands for 16 of these 18 projects (all except the Erie and Fulton projects). Pittman-Robertson funds also have been used to acquire lands for the Rose Lake Wildlife Experiment Station, for the Leidy Lake, Cannonsburg, Fish Point, Stanton and Wildfowl Bay projects started in 1949, and for other projects started since the beginning of 1950. In addition, lands were purchased in the Waterloo area and later turned over to the Waterloo Recreation Area, and 418 acres have been purchased for the Petobego project in Grand Traverse County.

ARTICLE 32-58

past expenditures. The study reported here represents only one segment of a comprehensive study of the game land acquisition program undertaken by the Department of Conservation. In this report an attempt is made to appraise and evaluate certain economic and local fiscal aspects of the wildlife area land acquisition program as it has operated in southern Michigan.

LAND USE SITUATION

Throughout its operation the land purchase program has aimed at putting lands to their optimum use. It has been generally recognized that good corn land can produce and support a better crop of pheasants than most undeveloped wild land. Yet proven agricultural land has seldom been acquired, even where it is available, for the simple reason that it is considered better suited for crop than for wildlife restoration use. Purchases for the most part have been limited to lands considered submarginal or of very limited value for farm use. The great bulk of the lands meeting this qualification are located in the northern counties. But the concentration of population in the southern part of the state has made it desirable to emphasize public land acquisitions in the southern counties.

Before the land acquisition program has been started in any area, relatively comprehensive surveys have first been conducted. These surveys have indicated the general value of the land for wildlife restoration purposes, the land use and cover conditions, and the appraised value of the land.

Valid arguments can be made for the location of game area projects on good as well as poor lands. Generally speaking, however, almost all of the Pittman-Robertson projects in Michigan are located in areas of third and fourth class lands, lands of the lowest value for farm use. While a large proportion of these lands are still undeveloped wild or marsh lands, farmers have cleared and attempted to cultivate considerable areas. This fact, however, does not provide conclusive proof that these lands are supramarginal for agricultural use.

Observations indicate that practically none of the acquired lands are suitable for commercial farm use under average conditions. With high farm prices and exceptional management some of them might provide a fair living for some farmers. Under existing circumstances, however, most of the purchased farm lands probably find their highest use in public ownership. The fact that many farmers have come to

Department of Conservation officials with offers to sell at the relatively low per acre price offered by the state and that every farmer selling out has done so on a purely voluntary basis is indicative of the feelings of the persons who have had most intimate contact with the lands in question regarding their capacity for agricultural production.

So far as the land use situation is concerned there has been no great change in the utilization practices applied on many if not most of the lands. The large areas of marsh and wild lands acquired are being preserved pretty much in their original state. In some cases, agricultural drainage ditches reaching into the areas have been dammed up to raise water levels and increase the size of marsh areas. In some of the wild land areas pines and shrubbery, such as multiflora rose, have been planted to provide additional game cover.

Only in cases involving abandoned or purchased farm land have many land use practice changes been made. In these cases the buildings have usually been removed and the lands often are left idle with weeds, grass and brush taking over the fields while an occasional old apple tree or lilac clump stands lonely and unattended. A few of the farm lands have been retained in agriculture. The usual practice in these cases has been for the Game Division of the Department of Conservation to lease the land to a nearby farmer on a share basis. The farmer has then proceeded to plant and raise a grain crop. At harvest time he has taken off his share of the crop but usually has left the Department's share unharvested in the field. The unharvested grain thus supplements the supply of winter feed available for birds and other wildlife.

LAND ACQUISITION COSTS

Most of the lands acquired with Pittman-Robertson funds have relatively little commercial value for other purposes. Accordingly they are usually available for purchase at relatively low prices. Occasionally, however, key holdings will command premium prices because they involve shore frontage, improvements or timber value, or an owner's recognition and full exploitation of his bargaining position. The prices paid for these lands tend to bring up the average prices paid per acre.

Analysis of the land acquisition cost data on the areas acquired prior to January 1950 shows that the average cost per acre varies from a low of $8.11 in the Minden City project to $93.45 in the case of the small Leidy Lake project. The average per acre price paid for

lands acquired in the 1945-49 period was almost double that paid in the 1939-44 period.

Altogether, 51,959 acres were acquired with Pittman-Robertson funds at an average cost of $19.69 an acre. If the above average prices paid for the more or less special case lands in the Rose Lake Wildlife Experiment Station and the Leidy Lake, Pointe Moullee, and Wildfowl Bay projects are excluded from the totals, the average price drops to $17.94 an acre. Excluding those four projects, an average price of $13.87 an acre was paid for the lands acquired between 1939 and 1944, while an average of $26.81 an acre was paid for the lands acquired in the 1945-49 period.

The variations between projects in prices paid reflect not only differences in time of purchase or option but also differences in location, land quality, and timber and recreational values. Wide differences also can be observed within project areas. Undeveloped wild lands without timber cover usually have little value. The tracts with improvements, on the other hand, cost considerably more.

As the accompanying tabulation of relevant data on two selected acquisitions shows, high and average prices per acre do not necessarily

Acreage acquired	77 acres	110 acres
Aver. price per acre	$64.93	$46.50
Proportion of appraised value assigned to—		
Land	24.5%	47.6%
Buildings	65.7	50.5
Timber and recreational value	9.8	1.9
Prorated average acreage price of land	$15.90	$22.13

indicate that a high price is paid for land. Actually the value assigned to the land might be quite low. The buildings acquired with the land do not represent a total loss because they are usually sold for salvage or otherwise put to use. Nor are the timber and recreation values lost with state acquisition. Instead, they ordinarily tend to appreciate as the lands are developed.

TAX PROBLEM

The purchase of privately owned lands for state game areas and the dedication of tax-reverted lands to this use reduce the property tax base of the local units of government. In times past, and for some

local units in particular, this type of program has given rise to critical fiscal problems. To avoid this type of situation, the Michigan Legislature in 1931 authorized payments of 10¢ an acre in lieu of taxes on all lands acquired by the Department of Conservation either through tax reversion or public purchase. These payments were earmarked for use by the townships and school districts and were prorated between them according to the ratio between their respective tax levies.

This state payment program was of considerable help to many local units of government, particularly in the northern counties where large areas tax forfeited to the state. With the acquisition of state game and recreation area lands in southern Michigan it also became important in this region. Whereas the 10¢ an acre payment program provided as much or more revenue per acre as most of the lands were capable of paying in taxes in the northern counties, it proved to be hardly an equitable arrangement on most of the recreation area lands and on some of the game area lands.

To remedy this situation the Legislature in 1946 amended the 1931 law (Act 5, P.A. 1946, Section 10a) to provide that all land and other real property south of town line 16 owned by the state, controlled by the Department of Conservation, and acquired by purchase since January 1, 1933, should be subject to regular taxation by the local units but should be assessed at an amount equal to 50 percent of the average assessed value of the property in the five years preceding its acquisition by the Department. Under this new arrangement the state paid many times its regular 10¢ an acre on some of the high value recreational lands near Detroit.[2] At the same time, however, it found itself paying less than 10¢ an acre on many of the less valuable game lands. In some of these cases, questions have been raised regarding the general equity of the state's payment-in-lieu-of-tax program.

EFFECTS ON LOCAL UNITS

The state's land acquisition and tax payment program affects the fiscal affairs of four types of local units—the counties, townships, school districts and drainage districts. All of these units can share in the present tax payments based on half of the assessed valuation that are

[2]Examination of the records on state payments shows that very few recreation area lands receive less than 10c an acre while a considerable acreage receives more than $1 an acre. By projects the average acreage payments made on the 1948 tax levy were: Bald Mountain project 32.7c, Brighton 19.8c, Bundy Hill 18.3c, Highland 55.9c, Holly 25.5c, Island Lake 23.7c, Metamora 29.4c, Onsted 25.0c, Ortonville 31.5c, Pinckney 15.3c, Pontiac Lake 34.5c, Proud Lake 31.7c, Rochester 36.2c, and Waterloo 14.4c.

paid on purchased lands. Only the townships and school districts, however, share in the 10¢ an acre payments made on tax-reverted game area lands.

In the case of the counties the loss of this revenue represents a minor item. With the drainage districts, it may be more important, depending upon the size and nature of the project and the area of game land involved. In this regard it should be pointed out that although state lands are not subject to special drainage taxes, under the drainage laws state land administering agencies can consent to pay varying proportions of drainage tax assessments. Up until a few years ago the Department of Conservation did not assume drainage taxes. Partly as an outgrowth of this policy the Tuscola County Board of Supervisors in June, 1944, adopted a resolution requesting the Department to refrain from buying other than Saginaw Bay frontage land in that county. This resolution has not as yet been rescinded. The Department policy regarding drainage assessments, however, has been modified. Outstanding drainage assessments are now paid up on all newly acquired lands. Tributary drains on some lands as in the Gratiot-Saginaw area have been abandoned. In other projects (notably in Sanilac, Tuscola, and Ingham counties) special drainage payments have been made by the state. These voluntary payments have not been based on the uniform per acre levies made by the county drain commissioner. Instead, they reflect a combination of negotiation and the Department's calculation of the benefit value of the drainage projects to its lands.

This study of the effects of the state payment program on local finances is limited mostly to its impact on township and school district taxes. Consideration should be given to three aspects of this problem: 1) the assessment procedure, 2) the effect on tax rates, and 3) comparison of the present tax payment program with the 10¢ an acre payment program.

The practice of assessing the lands purchased by the Department in the southern part of the state at 50 percent of their average assessed value in the five years previous to their acquisition can be questioned on two points: 1) the use of the 50 percent figure, and 2) basing the assessed value on a historical period. The procedure followed naturally gives the local units a smaller tax return than they would receive if the state's payment were based on 75 or 100 percent of the assessed valuation. At the same time, however, the state is under no compul-

sion to pay taxes to its local units. Its willingness to make payments based on taxation of half the assessed value represents a generous compromise—an arrangement that the local units have gladly accepted.

The use of a historical base in computing assessment values is more subject to criticism. It gives a slight advantage to those taxing districts in which lands have been assessed at a high proportion of their true value in the past. Also, in theory, it should give an advantage to those districts in which lands are purchased in periods of high land values. This assumes that land value assessments are or should be raised and lowered in accordance with trends in land values.

An illustration of the effect of changing price trends on land assessment values is found in the Gratiot-Saginaw area. An attempt was made in this area to follow through the assessment histories of comparable lands some of which were acquired by the Department and some of which remain in private ownership. The necessity for limiting comparisons to lands of comparable value tends to eliminate all properties with buildings, other improvement or timber value. This narrows the comparisons to wild undeveloped lands. In the survey made of this area before the acquisition program started, most of the lands in this class were appraised at $3.50 an acre. Their average full assessed value in the five years before many of them were purchased was $4 to $5 an acre. By 1949, however, the average assessed value of most of the remaining privately owned wild lands had increased to $10 an acre. A part of this increased value may represent timber growth; part of it may reflect anticipation of more state purchases in the area.

Even though this increase in assessed values probably reflects more than the usual proportionate upward adjustment in assessed property values found in Michigan during the past decade, it does suggest the unfortunate effect that the use of a historical base for assessment values can have on current tax levies and collections. It should be observed, however, that the use of the historical base approach protects the state against possible unwarranted increases in assessed valuations.[3]

At the time this study was undertaken it was recognized that the Department's land acquisition and tax payment program meant a

[3]In a number of townships with state game lands attempts have been made to increase assessed valuations. In a few of these cases local officials have objected to the state's use of the historical base in assessments and have requested adjustments to what they consider a fair assessed value.

reduction in the tax base and tax revenues of the local units. It was assumed that this reduction in revenues should reflect itself in higher tax rates on the remaining tax base. Under ordinary circumstances, assuming no reduction in need for public services, this would be the case. Illustrations of this situation were easy to find in the late 1920s and 1930s when thousands of acres were tax delinquent.

Actually, however, this has not been the case in the past few years. In some instances, it is possible that the land acquisition program has brought some reduction in public services (less need for school and road maintenance, abandonment of public drains and less need for police protection). The greater part of the reason, however, is found in the workings of the Michigan sales tax diversion amendment of 1946.

The diversion of state-collected sales tax revenues to the local units has so increased the funds at their disposal that many townships have found it possible to eliminate their general property tax levies. At the same time, many school districts have cut their taxes to or even below the 4-mill levy required by law for qualification for other state educational grants.

Examination of the 1948 tax data for the 45 townships with state game lands shows that 31 townships, 69 percent of the total number, made no regular property tax levy in 1948. Eleven townships made tax levies of one or less mills ($1 or less per $1000 of assessed valuation), while only three townships had regular levies of more than one mill.

The situation with regard to school districts is somewhat similar. Examination of the school district tax data for 1948-49 for the 41 reporting districts with state game lands in Barry, Gratiot, Ingham, Lapeer, Montcalm, Saint Clair, Saginaw, Sanilac, and Tuscola Counties indicates that 10 districts have tax levies of 4 mills or less, 14 have levies of between 4.1 and 6 mills, 6 have levies of between 6.1 and 8 mills, 4 have levies of between 8.1 and 10 mills, and 5 have levies of 10.1 mills or more. Of the districts with levies of between 8.1 and 10 mills only two have extensive holdings, while only one of the districts with levies of more than 10 mills has a large area of state-owned land.

An overall picture of the amount and distribution of the state's payments-in-lieu-of-taxes on its purchased Pittman-Robertson game lands is reported in Table 1. From these data it is seen that on the

TABLE 1—*Summary of 1948 data on tax-assessed acreages and values and state payments-in-lieu-of-taxes on Pittman-Robertson lands in southern Michigan*

Projects	Tax-assessed acreages and values*			State payments-in-lieu-of-taxes			Amounts needed to bring average payments per township up to a minimum of 10c per acre
	Total acres	Total of half assessed value	Average half assessed value per acre	Total acres	Total payments made	Average payment per acre	
Barry County	11,662	$68,712	$5.89	11,669	$1,100.55	9.4¢	$80.13
Dansville	2,645	23,435	8.86	2,640	345.26	13.1	.....
Deford**	3,804	17,880	4.71	3,803	359.01	9.4	79.03
Flat River	4,425	31,425	7.10	4,469	364.54	8.2	82.36
Fulton	652	5,450	8.36	652	71.64	11.0	.....
Gourdneck	1,262	14,575	11.55	1,037	297.31	28.7	.....
Gratiot-Saginaw	6,263	31,875	5.09	6,056	413.07	6.8	195.16
Gregory	648	7,790	12.02	775	102.01	13.2	.....
Lapeer	2,542	23,550	9.26	2,567	644.26	25.1	7.42
Minden City	2,799	14,287	5.10	2,784	184.17	6.6	94.23
Oakgrove	664	7,875	11.86	664	128.97	19.4	.....
Pte. Moullee	2,609	61,790	23.68	2,608	595.22	22.8	.....
Port Huron	5,229	41,892	8.01	5,234	819.03	15.6	2.57
Saginaw Bay	1,239	8,460	6.83	1,258	132.92	10.6	27.05
Three Rivers	.....	.....	.....	204	24.75	12.1	.....
Tuscola	2,759	9,000	3.25	2,759	212.34	8.0	63.56
Vassar	1,263	5,963	4.72	1,263	88.19	7.0	38.11
GRAND TOTAL***	50,465	$373,959	$7.41	50,442	$5,883.24	11.66¢	$669.62

*Total assessed values reported represent one-half of the average assessed value of the land in the five years previous to state acquisition.

**The state's payments to many townships include drainage assessments and this inclusion raises the average acreage payments somewhat. For example, of the $158.68 paid to Wells township (Deford project) on 1948 levies, $70.50 was paid on a drainage assessment. This raised the average acreage payment in the township from 8.1¢ to 14.6¢.

***Totals do not include assessed acreage or value data for Three Rivers project nor any data on the Erie project. Slight discrepancies between the total assessed acreage and acres on which state payments in lieu of taxes were made are for the most part traceable to differences in the manner in which the total areas involved were reported on two separate sets of records.

basis of 1948 tax assessments and levies the state paid $5,883.24 to the local units on 50,442 acres of purchased game lands, an average of 11.66¢ per acre. The average acreage payment by projects ranged from a low of 6.6¢ on the Minden City project lands to 28.7¢ on the Gourdneck project holdings. On a township basis the average acreage payments ranged from 3.8¢ on the Deford project lands in Kingston township of Tuscola County to 83.3¢ on the Pointe Moullee project lands in Brownston township of Wayne County.

Altogether the state paid an average of 10¢ or more per acre on its purchased game lands in 24 townships while it made average payments of less than 10¢ an acre in 21 townships. Tabulation of the

average acreage payment data for eleven principal projects[4] shows that an average of 10¢ or more per acre was paid on approximately 388 legal descriptions (mostly 40s), while an average of less than 10¢ was paid on approximately 710 descriptions.

It will be remembered that before the 1946 amendment to the state's payment-in-lieu-of-tax program was passed, 10¢ an acre was paid on all acquired lands regardless of whether they were acquired by purchase or reversion. At the time the amendment was passed it was assumed that tax payments based on half the assessed value of the property would bring larger revenues to the local units. This has been the case on the recreational area lands and in the majority of the townships with game area lands. This amendment has resulted in a net loss in revenue in many cases, however, and has created an anomalous situation in which a full 10¢ an acre is received on lands that tax reverted to the state while less than this amount is received on the lands the state found it necessary to purchase.

Various local officials have objected to this situation and contended that the state should pay a minimum of 10¢ an acre on all lands. As a substitute for this suggestion, a minimum average of 10¢ an acre could be set up for all the Department holdings in any township. A computation of the additional costs that the state would incur under this arrangement is included in the final column of Table 1. From this tabulation it appears that this modification would have cost the state only $669.62 on the 1948 taxes paid early in 1949.

SUMMARY AND CONCLUSIONS

On the basis of this analysis of the Pittman-Robertson land purchase program in southern Michigan the following conclusions seem in order:

1. The 80,356 acres thus far acquired by the state for wildlife restoration and public hunting grounds are far more suitable for recreational and game land uses than for agricultural purposes. By acquiring, developing, and administering these areas for game restoration and public recreational uses the state is probably putting these lands to their highest use and at the same time is helping to meet the demand for more public hunting grounds in the southern counties. Insofar as other lands of comparable type and value are available in

[4]The Barry County, Dansville, Deford, Flat River, Gratiot-Saginaw, Lapeer, Minden City, Port Huron, Oak Grove, Tuscola and Vassar projects.

southern Michigan, additional Pittman-Robertson funds probably should be used in acquiring them for public ownership and use.

2. Except for special sites, the average acreage price paid for the state game lands has been relatively low, about $18 per acre. The prices paid have varied considerably by projects and over time. Largely because of inflationary land market trends after the war, the average acreage price paid for the lands acquired since 1945 has been approximately double the average acreage prices paid between 1939 and 1944.

3. The exact effects of the public land acquisition program on the tax and fiscal problems of the local units of government have been complicated in recent years by the diversion of state sales tax receipts to the local units. This arrangement has made it possible for many local units to lower or even discontinue their usual property tax levies.

In theory at least, the removal of lands from the tax rolls through public acquisition should have an adverse effect on the tax base of the local units of government. The legislature recognized this problem in 1931 when it authorized annual payments of 10¢ per acre in lieu of taxes. Later this arrangement was modified in the southern counties to base the annual acreage payments on normal taxation of one-half of the average annual assessed value of the land in the five years previous to its public acquisition. Examination of the 1948 records shows that almost one-half of the townships with state game areas lost varying amounts as a result of this change in arrangements. This has caused a certain amount of friction and annoyance. On the basis of 1948 tax data, it appears that a modification of the present arrangement to permit the local units to choose the state payment arrangement most beneficial to them would cost the state approximately $670 in increased payments a year. This added cost would probably more than pay for itself in local good will.

THE OCCURRENCE OF VITAMIN B_{12} ACTIVITY IN PIG MANURE AS MEASURED BY CHICK GROWTH RESPONSE

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Cow manure (6) (7), incubated chicken feces (2), and incubated horse manure (3) have been shown to be potent sources of the animal protein factor (APF) which is required by chicks for normal growth. In the freshly voided state however, chicken feces (2), and horse manure (3) contain no APF, indicating that bacterial synthesis of this factor does not occur in the lower digestive systems of these animals.

Recent reports have shown that vitamin B_{12} has APF activity and is an essential vitamin for growth in the chick (1) (3) (5). Vitamin B_{12} is also essential for growth in the pig (4). It seemed of interest, therefore, to undertake the present study with the purpose in mind of extending the knowledge on the nutritional value of animal manures, and to determine whether bacterial synthesis of APF (in terms of vitamin B_{12} activity) is of significance in the intestines of pigs fed a corn-soybean diet.

PROCEDURE

Day-old, straight-run Rhode Island Red chicks (from hens fed a breeder mash containing fish, meat, and milk) which had been depleted during a 2-week post-hatching period were used for testing manure supplements. The period for testing, following depletion, was of 2 weeks' duration. The APF deficient diet used in the depletion and test periods, and the procedure for selecting the assay chicks have been described (3). The chicks were confined at all times in steel batteries with wire floors. Feed and water were given *ad libitum*.

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The manure samples used in this investigation were secured from three Berkshire sows maintained in dry-lot on concrete floors. Each was approximately two years old. They had been fed for 15 months a constant diet (APF deficient) of the following composition (in pounds): corn meal 77, soybean oil meal 20, complex mineral mixture 3, and vitamins A and D to provide 2,000 and 200 units per pound of feed, respectively.

Fresh feces were obtained from each pig by catching the droppings in clean enameled buckets during periods of exercise. Immediately after defecation, one-half of the sample from each pig was immersed in 95-percent ethanol and stirred. This stopped bacterial fermentation. The remaining portion was placed in an open metal container. Upon completing the collections (one-half day required) the manure-ethanol mixture was dried at 80° C. for 24 hours. This represented "dried fresh pig manure." The non-alcohol-treated feces were incubated for 4 days at 37° C., followed by drying at 80° C. for 24 hours. This represented "dried incubated pig manure." After drying, each manure preparation was finely ground in a hammer mill. Supplementation to the basal diet was made in the dry ground form.

RESULTS AND DISCUSSION

Two experiments were conducted. The results are given in Table 1. In the first experiment fresh pig manure and incubated pig manure were tested against vitamin B_{12} (0.000001 percent) and incubated horse manure (2.5 percent) for vitamin B_{12} activity. It was found previously (3) that these levels of vitamin B_{12} and incubated horse manure produced a maximum growth response in chicks under the conditions employed. The data show that at the 2.5-percent level the fresh pig manure had no vitamin B_{12} activity whereas the incubated pig manure had high potency, being equivalent to the supplements of incubated horse manure and vitamin B_{12} in promoting growth.

In the second experiment the pig manures were re-tested at two levels of supplementation (2.5 and 5.0 percent). It was previously reported (3) that a combination of B-complex vitamins stimulated growth in chicks fed the basal diet but that the effects of these vitamins and vitamin B_{12} on growth were distinct and additive. Therefore, in the second trial all of the groups received a supplement of synthetic vitamins (see footnote ‡, Table 1) as a precautionary measure against the possible growth stimulating influence of certain known vitamins which may have occurred in the manures. Again, as was observed in

TABLE 1—*Vitamin B_{12} activity of fresh and incubated pig manure*

Group No.	Supplement to basal diet*	Average gain 2-4 weeks, in grams	No. died
	Experiment 1 (12 chicks per group)		
1	None	59.0	0
2	0.000001% B_{12}†	113.2	0
3	2.5% Dried incubated horse manure	101.2	0
4	2.5% Dried fresh pig manure	66.4	1
5	2.5% Dried incubated pig manure	102.3	2
	Experiment 2‡ (12 chicks per group)		
1	None	88.8	0
2	0.000001% B_{12}†	119.2	0
3	2.5% Dried incubated horse manure	114.5	1
4	2.5% Dried fresh pig manure	77.9	0
5	5.0% Dried fresh pig manure	82.9	2
6	2.5% Dried incubated pig manure	108.8	0
7	5.0% Dried incubated pig manure	111.7	1

*All manure supplements added to the basal diet at the expense of corn.

†Fed as vitamin B_{12} concentrate: Merck's charcoal adsorbate containing 2.0 milligrams of vitamin B_{12} per pound.

‡All groups in Experiment 2 received the following vitamins (in milligrams per kilogram of diet): thiamine hydrochloride 2.0, Ca pantothenate 15.0, pyridoxine hydrochloride 4.0, PGA 1.0, and biotin 0.2.

Experiment 1, the fresh pig manure contained no vitamin B_{12} activity inasmuch as the 2.5 percent and 5.0 percent levels both failed to promote growth. In contrast the same amounts of incubated pig manure exhibited high potency in vitamin B_{12} activity.

The results presented show quite conclusively that the fresh pig manure contained no vitamin B_{12} activity that could be measured, at least, by the chick growth test used in this study. On the other hand, incubated pig manure was a highly potent product, having become active as a result of microbial fermentation after defecation. We interpret these findings as indicating that bacterial synthesis of vitamin B_{12} active substances does not occur in the intestines of pigs fed APF deficient diets.

SUMMARY

A short chick growth test, 14 days in length, was employed to measure vitamin B_{12} activity in fresh and incubated pig manure. The incubated pig manure was found to be highly potent whereas fresh pig manure contained no vitamin B_{12} activity. The evidence indicated that bacterial synthesis of vitamin B_{12} activity did not occur in the intestines of the pigs studied, but came as a result of microbial fermentation after defecation.

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BREED DIFFERENCES IN MEAT TYPE SCORE AND WEIGHT OF 12-WEEK-OLD COCKERELS

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FRIED CHICKEN with ample breast meat is a delicacy which most homemakers would like to serve. In order to satisfy the requirements for plump-breasted chicken the producer has the problem of selecting live birds with superior meat type. Differences in meat type among breeds may be more traditional than actual in many cases, but experimental evidence of differences measured under uniform environmental conditions is scarce.

A number of observations of meat type and weight under comparable conditions have been made at this station. Some of the data are presented in Table 1. While other observations have been made the averages reported herewith are restricted to samples of male chickens which had a uniform environment.[2]

COMMENTS ON DATA

The average meat type scores[3] and weights are apparent in Table 1. Many of the averages are nearly identical and some measure of degree of difference is necessary. It is well known that measurements vary by chance for a multitude of reasons and that there is an element of probability in all averages. In short, averages do not mean much unless accompanied by some statistically calculated measure of their reliability. The relative reliability or "significance" of the averages in Table 1 was calculated statistically[4] but the details are omitted because of space limitations.

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[1]Research Assistant Professor of Poultry Husbandry, Michigan Agricultural Experiment Station.

[2]Mr. Maurice Armstrong operated the incubators and battery stages of brooding. Dr. A. C. Groschke was responsible for the compilation of feed formulas. Mr. Eino Niemala, farm foreman, was responsible for the detailed management of the chickens.

[3]1 (best) to 5 (poorest); for detailed explanation see Mich. Agr. Exp. Sta. Quart. Bul. 28:1, 1945, and 28:3, 1946.

[4]Significance determined by the method of analysis of variance. Fisher, R. A., 1930. Statistical methods for research workers. Oliver and Boyd, Edinburgh.

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The average meat type score of the Dark Cornish is the best[5], that of the white cross breds is second, and surprisingly enough, the Leghorn average ranks third. The sample of Leghorns is definitely not representative of Leghorns in general because it is from a population which has been bred at this station by the writer for improved meat type. The score of the New Hampshires is better than that of the Reds, but there is no difference between the two strains of New Hampshires (column 4 vs 5) nor between that of the New Hampshires and White Rocks. The average scores of the Reds and Barred Rocks are not far enough apart to be significant[6], and they are not so good as the average of all scores.

GENERAL INFORMATION OF SAMPLES

Just how representative of the breeds in general that the sample averages of this report are must remain a matter of opinion. Absolutely representative averages would require measurements of a sample consisting of all the members of each breed after growth under identical conditions. Such a comprehensive sample is inconceivable and since the samples presented cannot be so comprehensive, they are offered merely for comparative purposes.

The samples of the several breeds are probably not far from the averages of the breeds indicated except the sample of Leghorns as previously noted, and the Cornish. The Cornish sample is probably not as good as the average for the breed in general because it was drawn from a population which has been bred primarily for egg production ability. It is probable that there is not as much difference in meat type score among breeds at 12 weeks of age as there is at later ages.

The Reds, New Hampshires, White and Barred Rocks are from several commercial lines of breeding and considered reasonably representative of the average of their respective breeds. The writer is well aware that there have been averages calculated from other samples of a few of the breeds described which differ widely from those reported herewith, both with respect to meat type score and weight.

The white cross breds are largely fourth to seventh generation descendants from an original Dark Cornish, White Leghorn reciprocal cross. Their ancestry was selected for meat type along with dominant

[5]See footnote [4].
[6]See footnote [4].

white plumage color, white egg shell color and production characters. The Cornish are mainly of the Dark variety but a few of them are of the White and White Laced Red variety.

SAMPLE SIZE

The numbers of chickens in the breed samples may be considered small or large depending upon what degree of precision one is accustomed to working with. A chemist may be satisfied with duplicate or triplicate samples of determinations. A corn breeder may regard two ears of corn with 200 or more individual kernels (400 progeny) as a small sample, but a horse or cattle breeder might regard 400 animals as a large sample. In general, a sample need be no larger than necessary to yield statistical significance. By that criterion most of the samples of this experiment were large enough.

THE ENVIRONMENT

Some of the essential features of the environment to which the several breeds were subjected were as follows: 1) they were hatched in the same incubator on the same date, February 1, 1949 with one unimportant exception[7]. 2) They were brooded and grown in the same house in pens of identical type and size[7]. 3) They had access to the same feeds.

In the case of the single difference in hatching date whatever advantage or disadvantage the chicks of this hatch might have had is considered insignificant. All the chicks were grown in a common moderately heated house for at least 11 of the first 12 weeks of their lives. They were all scored and weighed at 12 weeks of age by the writer.

BREED DIFFERENCES BETWEEN AVERAGE WEIGHTS

The average weights of the several breeds differed more widely than the average meat type scores of the same samples. Both samples of New Hampshires were significantly heavier at 12 weeks than all the others. While there is an apparent difference in average weight between the two strains of New Hampshires the difference is not significant. In other words, the variation in weight within the two samples

[7]The Dark Cornish were hatched one week earlier than the others. The New Hampshires were moved to a colony brooder at 11 weeks of age.

is relatively greater than that between the two and would indicate that other samples bred from the same populations might very probably yield more nearly equal averages.

The average weight of the White Rocks is unexpectedly low. Individual White Rocks weighed as much as 3.8 pounds. There were many White Rocks in the three pound class but there were enough below that weight to pull the average down. The White Rock average is not significantly below the Leghorns or Cornish, although all three are below the average of all the breeds. The White Rocks weighed significantly less than the Barred Rocks. There were at least four strains represented in the White Rock average. The differences between the averages of the Rhode Island Red, Barred Rocks and White cross breds were not quite significant, but the Barred Rocks were below[5] the general average of 3.1 pounds.

GENERAL IMPLICATIONS OF DATA

WITH RESPECT TO MEAT TYPE

The differences between the meat type scores of the several "breeds", tend to substantiate at least two of the ideas which motivated the original experiment: 1) A strain of S. C. White Leghorns can be developed in five or more generations which will have better meat type at 12 weeks than the present average of the so-called heavy breeds. 2) Superior meat type can be maintained in the descendants of a cross between Dark Cornish and White Leghorns.

WITH RESPECT TO GROWTH RATE

The differences in weight at 12 weeks show very clearly that the New Hampshires sample had a superior growth rate and that one of the principal deficiencies of the meat type breeds in this experiment was slow growth.

Whether faster growing strains of meat type Leghorns can be developed out of the original strain without decline in meat type is a problem for the future. The best weight attained by a single cockerel at 12 weeks among the Leghorns was 3.5 pounds. This individual was scored 3.6 for meat type. The best weight and corresponding meat type score among the Cornish was 3.5 pounds and 3, respectively.

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[5]Statistically significant.

TABLE 1—*Averages of meat type score of 12-week-old cockerels**

Column No.	1	2	3	4	5	6	7	8	9
Breed	White Leghorn	White Cross-Breds	Rhode Island Reds	New Hampshire strain A	New Hampshire strain B	White Rocks	Barred Rocks	Cornish	Total or average of total
Numbers in sample	75	45	92	66	73	46	46	38	481
Average meat type score	3.8	3.4	4.3	4.1	4.1	4.1	4.4	3.0	4.0
				Average Weight in Pounds When Scored					
Average weight in pounds*	2.70	2.9	3.0	3.9	3.7	2.6	2.9	2.7	3.1

*Averages rounded to the nearest 1/10th.

FACTORS IN RATE OF IMPROVEMENT EVIDENT IN LEGHORNS

Speed of improvement in meat type of the Leghorns was handicapped in this experiment by the small numbers available to select from. The number of chicks to select from in any one year did not exceed 600. No more than eight single male mated pens were utilized in any year. With two exceptions selection was limited to descendants of the State College flock which was available in 1943. The two introductions of relatively unrelated strains did not enhance meat type at all. Average growth rate was improved an insignificant amount by the introduction of two strains of "outside" stock. This stock consisted of one male and one female from one strain (line 4) and four females from another strain (line 5). Thirteen percent of the Leghorn sample carried one quarter of the "blood" of line number four and 20 percent carried one quarter of the "blood" of line number five.

SUMMARY AND ABSTRACT

Breed differences between meat type scores and weight of 481 12-week-old cockerels were analyzed statistically. Significant rank with respect to meat type score was as follows: 1) Cornish, 2) Cross-bred whites, 3) "Meat type" Leghorns, 4) New Hampshires and White Rocks, 5) Rhode Island Reds and Barred Rocks.

Significant weight rank was 1) New Hampshires, 2) Rhode Island Reds, White cross breds and Barred Rocks, 3) Cornish, Leghorn and White Rocks.

Evidence that meat type of purebred S. C. White Leghorns can be improved by selection beyond that of the average of existing heavy breeds is presented.

WHAT CONSUMERS THINK ABOUT THE EGGS THEY BUY[1]

By H. E. LARZELERE and W. A. NICHOLS
DEPARTMENT OF AGRICULTURAL ECONOMICS

OPERATORS OF A GROUP of egg grading stations in Michigan are convinced that success in their operations is pretty closely tied to consumer egg-buying practices. These operators have had, for at least the last 10 years, programs for encouraging producers to produce high quality eggs. Price incentives, as well as educational efforts, have been used. Likewise, in their own plant operations they have emphasized adequate grading and handling procedures so as to be able to merchandise a good quality product. Most of the eggs have been sold to wholesalers and jobbers or direct to retailers.

Grading stations can gage the attitudes of consumers toward their particular eggs by repeat sales and the interest of wholesalers and retailers in handling eggs from the various stations. There still are, however, answers to a number of more or less specific questions that pertain to the handling of the eggs by wholesalers, retailers, and consumers that station operators wish to have. Many of these questions were included as part of a questionnaire distributed to consumers by inserting them in the carton at the time of packing at the stations. Since nearly all the eggs cartoned at the stations were U. S. Grade A, or equivalent, practically all of the questionnaires were put in cartons of top quality eggs.

There were 2,745 schedules distributed through seven stations during 1949 and early 1950. A total of 182 schedules were returned. The purchasers had obtained the eggs through 84 different retail outlets, located in Greater Detroit, Ann Arbor, Ypsilanti, Pontiac, Lansing, Grand Rapids, Saginaw, and Mt. Pleasant. By a code number which

[1]The writers acknowledge the assistance given in this survey by the following: J. A. Davidson and L. E. Dawson of the Poultry Husbandry Department, the personnel of the egg grading stations, and the consumers who returned the questionnaires. Further work along this line is being carried on in a project in which the complete history of samples of eggs is being recorded from the farm to the consumer.

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identified the station, date, grade and size of the eggs with which each schedule was packed, it was possible to compare preferences of consumers with actual purchases made. Some of the results of this study are listed below, together with some suggestions for improvement in the handling of eggs.

TIME BETWEEN PACKING AND SALE TO CONSUMER

The purchasers were asked to report the dates they had obtained the eggs. By comparing these dates with the date of packing, the length of time involved in the wholesaling[2] and retailing functions could be determined. The average elapsed time between packing and purchase by the consumer for the 182 purchases was 7.1 days, ranging from 1 to 34 days. Table 1 indicates the distribution of the time intervals. Because of the important effect of elapsed time upon changes in egg quality[3], it would appear that a faster movement or turnover of egg supplies might well be undertaken by the wholesalers and retailers in order to maintain better quality.

Improvement in this direction can be worked on by the grading stations by educational efforts with other handlers, and by more frequent deliveries to the retail outlets. More frequent deliveries would involve additional expense but would likely be economically feasible in those instances where there was a relatively long period between packing and sale to the consumer.

QUANTITY AND FREQUENCY OF PURCHASES

Slightly over half of the purchasers reported buying eggs one dozen at a time. However, individual consumers buy as many as eight dozen.

Table 2 indicates the response to the question "How often do you purchase eggs?". As might be expected, it can be observed that in general, the more frequent the egg purchases the smaller the quantity obtained at each purchase.

The frequency of consumer purchase would warrant the practice on the part of retailers of moving their entire stock of eggs, a perishable commodity, at least once a week while their suppliers, whether city wholesalers or country grading stations, have the responsibility of delivering eggs often enough to make this possible.

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[2]Four of the stations sold all or part of their eggs directly to retail outlets.

[3]"Changes in Egg Quality During Marketing," North Central Regional Publication 15, Mich. Agr. Exp. Sta., East Lansing, Michigan, Spec. Bull. 361, August, 1949.

TABLE 1—*Distribution of time intervals between packing and sale to consumer*

Time between packing and sale to consumer	Percent of purchases	Number of purchases
0 - 3 days	27.5	50
4- 7 days	35.2	64
7–14 days	28.0	51
15–34 days	9.3	17

BUYING PRACTICES

In establishing sound merchandising policies, egg handlers are interested in knowing what some of the buying practices of consumers are. In order to get at this problem the purchasers of the eggs were asked "Which of the following do you usually pay attention to when you buy eggs—size, brand name, grade, or price?" Grade was of importance to the largest number of purchasers (92 percent), followed closely by size (85 percent). Price was third (57 percent) and brand name fourth (20 percent) in importance among the buying practices. The relative importance of grade to the consumer warrants the careful attention of packers to good grading practices to insure continued acceptance of their eggs. The reader should keep in mind that any one of those factors, regardless of their consideration by all consumers, may be all important to certain individual consumers.

HOW IMPORTANT IS SHELL COLOR?

Considerable discussion takes place between producers and handlers as to the relative merits of brown and white shell eggs. Michigan poultrymen having heavy breeds in their flocks are, of course, interested because of the discount of 2 to 4 cents a dozen which the Detroit wholesale market usually allows for brown-shelled eggs. In response to a question on shell color preference, 57 percent of the consumers in this survey indicated no preference for one shell color. In relating this opinion to the eggs actually bought, one-half of those buying white

TABLE 2—*Quantity and frequency of usual egg purchases*

Frequency of purchase	Number of purchasers	Average quantity purchased
Twice or more a week	52	1.4 dozen
Once a week	108	1.6 dozen
Once in two weeks	22	2.2 dozen

TABLE 3—*Shell color preferences and shell color actually purchased*

Shell color preference	Number of purchasers	Percent of white egg purchasers	Percent of brown egg purchasers
None	104	51.2	70.2
White	61	42.4	14.0
Brown	15	5.6	14.0
Both, depending on use	2	.8	1.8

eggs reported no preference, whereas two-thirds of those buying brown eggs indicated no preference. As might be expected, Table 3 indicates that a larger proportion of white egg purchasers than brown egg purchasers preferred white eggs. A similar relationship existed with the brown egg purchasers and brown shell preference. However, the latter were apparently not as particular as those preferring white eggs. It should be recalled, of course, that the color of eggs purchased does not necessarily reflect the individual preference since both brown and white eggs are not always available for the individual to make a free choice.

EGG YOLK COLOR

Those concerned with types of feed and feeding practices of poultry have been concerned with the yolk color that consumers prefer. The purchasers of eggs in this study were asked whether they preferred light, medium, or dark yolks, or had no preference. A large number of the purchasers indicated a preference for medium colored yolks. The other opinions on yolk color are indicated in Table 4. One additional voluntary comment included was: "Everyone in the family likes a different kind. How can one shop under such circumstances?"

It is of interest to note that light yolks are not the most popular type even though occasionally some handlers and producers have felt

TABLE 4—*Egg yolk color preference*

Color of yolk	Number of purchasers
Light	45
Light or medium	3
Medium	72
Dark	10
No preference	51*
No answer	1
Total	182

*See quoted comment on this page in section, "Egg Yolk Color".

that a light-colored yolk was most desirable. In making this contrast, however, the writers recognize the limitations of expecting uniform judgment on yolk color from a number of different persons.

COMPLAINTS

The question "Do you have any complaints regarding these eggs?" was asked the purchasers. A total of 144 had no complaints, or did not check the question, and 38 had one or more. Several of the 144 who did not have any complaints did add comments such as "perfect", "very good", or "I rely on store reputation".

The following types of complaints were included on the schedule for checking: a) poor flavor, b) bad odor, c) watery white, d) dirty shell, e) too light a yolk, f) too dark a yolk, g) dark spots on yolk, h) yolk breaks too easily. Each of these types was checked at least once. In addition the comments: "Shells break too easily", "Too high a cost", "Poor flavor", "Not standard graded", and "Blood spots", were added voluntarily by the purchasers. There were a total of 64 different complaints in the 38 purchases in which the consumers were not entirely satisfied.

While only 38 purchasers out of the total of 182 had complaints regarding the eggs, producers, egg handlers and consumers alike realize that one serious complaint about eggs discourages the purchase of eggs from a particular outlet, and often times reduces the number of eggs consumed by the individual who has a complaint. For those reasons, it is desirable to determine some of the facts associated with the complaints.

There was little difference between the number of complaints on the eggs from the various egg grading stations. Complaints were in close proportion to the number of schedules originating in the various stations. There was a larger percentage of the brown egg purchasers (28 percent) who had some complaint than those who purchased white ones (17.5 percent). In some of the individual types of complaints this pattern between brown and white was rather consistent. The most common complaint, "yolks break too easily", (15) was made on 7.2 percent of the white egg purchases and 10.5 percent of the brown. Next was "watery whites" (13) made on 6.4 percent of the white egg purchases and 8.8 percent of the brown. "Dark spots or blood spots on the yolk" occurred 11 times; more frequently with the brown eggs. Table 5 indicates the distribution of the other complaints. All of the com-

TABLE 5—*Number and type of complaints of egg quality among white- and brown-shelled eggs*

Type of complaint	Number of complaints	Percent of white egg purchasers	Percent of brown egg purchasers
Yolks break too easily	15	7.2	10.5
Watery whites	13	6.4	8.8
Dark spots or blood spots on yolk	11	3.2	12.2
Too dark a yolk	7	3.2	5.3
Poor flavor or odor	5	3.2	1.8
Dirty shells	5	.8	7.0
Shells break too easily	3	1.6	1.8
Too light a yolk	2	1.6	0.0
Miscellaneous	3	1.6	1.8
Total	64	—	—
Number of purchasers with one or more complaints	38	17.5	28

plaints except poor flavor or odor, are known to be influenced largely by inherited traits of the layers or feeding practices. Flavor and odor can sometimes be influenced by the individual hen and lapse of time; humidity and temperature also may have an effect upon the conditions described as "yolks break too easily" and "watery whites". In this study, however, the last two types of complaints were not found to be directly associated with the longer periods of time between packing and consumer purchase. Conditions of humidity and temperature were not recorded in this study.

The complaints of poor flavor or odor appeared with purchases in which there was a relatively long period (11.6 days) between packing and consumer purchase. Flavor and odor are often influenced by the tendency of eggs to absorb odors from other materials with which they are kept, and the longer they are kept under such conditions the greater the odor or flavor absorbed.

HOME USE AND CARE

The most common use of these eggs as reported by the 182 egg purchasers, was for breakfast, presumably in fried form, soft cooked (soft-boiled) or poached. Use in baking was second in importance, followed by hard cooked (hard-boiled) and custards.

Nearly all of the purchasers in this survey (96 percent) reported keeping their eggs in a refrigerator. This indicated that most of the purchasers of the eggs realized the importance of proper care of eggs in the household.

CONCLUSIONS

On the basis of the consumers' preferences given in this report, three suggestions may be made: 1) Maintenance of a rapid turnover in the stocks of eggs held, a recommendation desirable for the grading station, the city wholesaler, retail store. 2) Greater attention in grading operations to the candling of brown-shelled eggs because of the apparent tendency for more of the off-grade qualities to appear with the so-called top quality eggs. This policy, if maintained, could probably do much to reduce the discounts on brown-shelled eggs, as indicated by the apparent general willingness for most consumers to use eggs of either color. 3) Further, specific attention can be well directed by poultry breeders to develop birds, and by poultrymen to use such strains of birds in their flocks which tend to lay a minimum of eggs having the undesirable characteristics mentioned above.

BREED AND EGG WEIGHT VARIATION IN INCUBATION PERIOD

By E. W. HENDERSON[1]
DEPARTMENT OF POULTRY HUSBANDRY

THE POSSIBLE influence of egg size or weight on speed of hatching has not received much attention from research workers. Some of the pioneer commercial hatcherymen[2] believed that small and/or white eggs hatched earlier than large and/or brown eggs. Since the advent of national uniform rules of procedure for commercial hatcheries in 1935, there is probably less variation in size of eggs set than there was before 1935. At any rate present-day hatchery operators do not notice much if any difference in incubation period among eggs of various sizes and colors.

Some of the ideas of relationship between incubation period and egg size may be inferences from general observations of differences between species. It is well known that eggs of turkeys, ducks, geese and swan are larger than those from chickens and require longer to hatch. One striking inconsistency in the general difference between species is that between the Ring Neck pheasant and its close relative, the chicken. It is well known that pheasant eggs are much smaller than those of chickens, but they require slightly longer to hatch. There is inconsistency within species among breeds of domestic fowl also. Dark Cornish eggs at this station, with average weight definitely below most other breeds, seems to require approximately the same incubation period. This seems to suggest that incubation period is inherent and independent of size of eggs.

PARTIAL REVIEW

Henderson (1930) found little difference in embryonic growth rates among Dark Cornish and White Leghorns and their reciprocal cross

[1]Assistant Professor (Research) of Poultry Husbandry.

[2]Personal letter from T. S. Townsley, formerly in charge of research for Smith Incubator Company, Cleveland, Ohio.

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breds. Later Byerly (1930) made similar observations of Leghorns, Rhode Island Reds and reciprocal crosses. Embryonic growth rate has been assumed to be synonymous with incubation period but this has not been proven to date. There is no known way to measure the progressive weight of an embryo that will permit it to hatch normally.

Warren (1949) credits Byerly (1934) and McNally and Byerly (1936) with the statement that larger eggs require a longer incubation period. Warren's interpretation of Byerly's report is correct, but his reference to McNally and Byerly (1936) seems to be either an unwarranted inference or a misquotation.

EXPERIMENTAL EVIDENCE

ORIGIN OF EGGS

During the course of a statistical analysis of incubation data at this station a difference in length of incubation period was apparent between some eggs from two pens of Barred Rock hens mated to two White Cornish males and eggs from their purebred pullet daughters when mated with Barred Rock males. Since the eggs from the two groups were incubated at the same time in the same compartment, a delaying influence of the White Cornish sires was implied[3] at that time. There was a slight difference in incubation period also between eggs from White Leghorn hens and their pullet daughters. The White Leghorn hens were mated with two Dark Cornish males and the daughters were mated with White Leghorn males. Some purebred eggs from Rhode Island Red pullets were incubated in the same compartment at the same time.

SUMMARIZED DATA

The average incubation period and average weight of all eggs hatched from the several breeds at the particular time are indicated in Table 1. Since the eggs from the White Cornish x Barred Rock hen matings required significantly longer to hatch, they are separated in the table and are not included in some of the statistical analyses which will be described later. It is quite evident that the average weight of the eggs from the Barred Rock hens is larger than those of their pullet daughters and all the others. It was suspected that the tray in which they were set may have received some unknown influence, such as low temperature. The temperature was recorded for the

[3]Report of Henderson and Champion, 1948.

entire compartment as standard procedure. Uniform results had been observed from the compartment in the past and there was no reason to indicate that the temperature of the individual trays should have been recorded.

STATISTICAL EVIDENCE

Since there was a suggestion of some relationship between egg weight and incubation period in these data, it seemed advisable to calculate the correlation coefficients. Inconsistencies in the data indicated that the choice of a sample might have an important bearing on the validity of results; therefore, samples were selected in four different ways as follows: 1) The entire sample of all eggs hatched, without respect to ancestry (many incubation research reports in the past have not included identity of the ancestry of individual eggs); 2) an arbitrary sample which was restricted to those eggs which ranged in weight from 54 to 65 grams inclusive. Since the restriction automatically eliminated most of the eggs from the Barred Rock hens, they were all eliminated from the sample. This sample was considered an approximation of common hatchery practice. 3) Samples of each breed separately and 4) the original sample excluding the eggs from the Barred Rock hens.

RESULTS FROM THE FIRST SAMPLE

The correlation obtained from the first sample (+ 0.37) was highly significant and demonstrates conclusions which might be drawn from

TABLE 1—*Incubation period* and egg weight of matings*

Mating	Number of eggs hatched	Average incubation periods	Average egg weight, in grams	Correlation between speed of hatching and egg weight
DC x WL (hens)	68	2.9	62.7	+.21
WL x WL (pullets)	67	2.6	61.0	+.05
RIR x RIR (pullets)	65	2.6	59.2	+.25†
BR x BR (pullets)	64	2.75	59.2	+.17
Sub total	264	.....	.....	+.18‡
Average	.....	2.7	60.3	.....
WC x BR (hens)	80	6.1	64.3	−.11
Totals	344	3.5	61.0	+.37‡

*Code for emergent period. i.e. Eggs hatched during the first 6 hour period (6-12 p.m. of 21st day) were classified in incubation period No. 1, those hatching in the next 6 hour period No. 2, etc.
†Significant beyond the 5-percent point from Snedecor's tables. p. 125.
‡Significant beyond the 1-percent point from Snedecor's tables. p. 125.

TABLE 2—*Analysis of covariance. Sums of squares and sums of products*

Source	D/F	Sx^2	Sxy	Sy^2	Errors of estimate		
					Sums of squares	D/F	Mean square
Total	343	8844	1436	1507	1274	342	.....
Breeds	4	1387	945	735	.....	.....	.....
Within breeds	339	7457	491	772	740 534	338 4	2.18 133.*
Test of significance of adjusted breed means						F =	61.*

a rather common method of sampling in which the variation due to inherent potentialities of individual eggs is either unknown or ignored. The test for significance between adjusted breed means in the analysis of covariance calculated from this sample (Table 2) yielded an F value of 60.5[4]. This was interpreted to mean that average egg weight of the lots did not explain all the differences among the breed average incubation periods since they differ significantly after adjustment to a common egg weight basis. This seems to confirm a delaying influence of the White Cornish sires. Unfortunately we have no other basis for estimating the incubation period of the population from which the White Cornish sires were drawn because no ancestral record is available for them.

RESULTS FROM THE SECOND SAMPLE

The correlation coefficient calculated from the second sample is 0.18[4]. Reassembling of the data for the second sample affected the range in egg weight and incubation period. The original range in egg weight of the entire sample (minus the Barred Rock hens) was as follows: 54–73 grams for the Leghorn hens, 50–71 grams for the Leghorn and Red pullets, and 50–70 grams for the Barred Rock pullets. (The weight of the Barred Rock hen eggs ranged from 59–72 grams but they were not included in the calculations.) All eggs weighing less than 54 grams and more than 65 grams were excluded on the assumption that this selection might approximate standard hatchery practice. The sample of Leghorn hen eggs was not affected very much because none of the original samples of eggs were below 54 grams in weight. The numbers in the original sample were reduced from 344 to 210 eggs by the arbitrary sampling method.

[4]Significant beyond the 1-percent point.

RESULTS FROM THE THIRD SAMPLE

From the third sample coefficients of correlation were calculated for the eggs from each breed separately. The results are summarized in Table 1. While the correlation coefficients are positive for all the breeds, only one has a probability of significance beyond the 5-percent point—the Rhode Island Reds. The correlation from the Leghorn hens approaches significance. A tabular value of 0.21 would be significant for a sample of approximately 85 eggs. The negative value from the 80 Barred Rock hen eggs was surprising and emphasizes the contradictory behavior of this sample. One might speculate that the eggs are all large for the breed, therefore, the incubation period was affected more by inheritance than by the weight of eggs.

RESULTS FROM THE FOURTH SAMPLE

An analysis of covariance was calculated (Table 3) from a sample consisting of all breeds excepting the Barred Rock hens. An F value of 0.28 was obtained for the adjusted breed means which indicated that there was not a significant difference between the breed means after adjustment to a common egg weight. This final sample seemed appropriate for calculating the regression of incubation period (y) on egg weight (x). The formula for the regression is shown in Fig. 1 ($y = 0.06\,x + 2.0$). Both incubation period and egg weight were coded as follows: One incubation period unit equals 6 hours from the time the first egg hatched. One egg weight unit equals 1 gram plus 49 grams. It is apparent from Fig. 1 that eggs weighing 50 grams can be expected to hatch in the first 6 hours of a normal hatching period and eggs weighing 70 grams can be expected to hatch about 7.5 hours later. Eggs weighing 59 grams or a little over 2 ounces can be expected to hatch midway between the extremes or about 3 hours later than the smallest eggs.

TABLE 3—*Analysis of covariance. Summary of data*

Source of variation	D/F	Sums of squares and products			Errors of estimate		
		Sx^2	Sxy	Sy^2	Sums of squares	D/F	Mean square
Total	263	6035	376	633	610	262	.....
Breeds	3	239	28	5	.....	.....	.....
Within breeds	260	5796	348	628	608	259	2.34
					2.0	3	.66
Test of significance of adjusted breed means						F =	.28

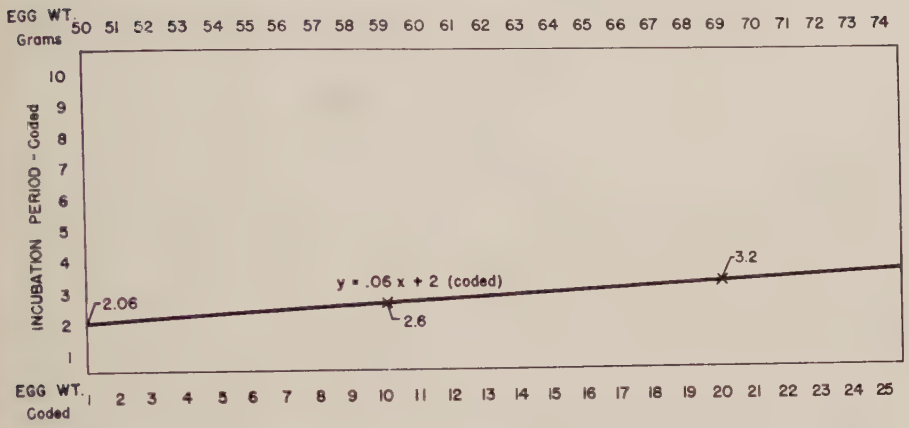

Fig. 1. Regression of incubation period on egg weight.

SUMMARY AND ABSTRACT

A highly significant correlation coefficient (+ 0.18) was determined between weight of eggs (independent variable) and the length of the incubation period (dependent variable). Breed differences in incubation period were suggested but within breed correlations were not uniformly significant from the numbers available.

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THE OCCURRENCE OF SOUR EGGS IN STORED EGGS

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SOUR EGGS, in the last three or four years, have been found in larger numbers among storage eggs. This is one of the many problems encountered in maintenance of quality in storage eggs. The storing of eggs has been a means of taking care of fluctuations in egg supplies.

Sour eggs have a decidedly unpleasant odor and therefore are inedible. The albumen, usually greenish in color, is liquefied and may be stringy. The yolks may appear partially cooked or "crusted".

The early souring of eggs is very difficult to detect by commercial candling methods. Many eggs that are beginning to sour will be missed by more careful candling methods. Occasionally the green color of the albumen can be seen in eggs with white shells. After longer periods of storage the albumen at the small end of the egg appears stringy and the yolk shadow appears high, reddish and dark. These characteristics are not entirely reliable since they may be found in edible storage eggs.

CAUSE OF SOUR EGGS

Lorenz and Starr[1] state that there is good evidence that sour eggs are caused by members of the genus *Pseudomonas*, a widespread soil microorganism that generally develops at low temperatures and which might be expected to thrive in poultry house litter or in the soil of poultry yards. The eggs are infected after they are laid.

The increase in number of sour eggs in recent years may be due to changes in the method of handling soiled eggs. More eggs are being cleaned since many receiving stations are paying a premium for clean eggs. This means that more farmers and poultrymen are washing their eggs. Formerly the heavy dirties were not cleaned be-

[1]Lorenz, F. W. and Starr, P. B. 1949. The Sour Egg Problem. California Agriculture, 3 (2) (Feb.); 13.

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cause it was a laborious, time-consuming job and in many cases the light dirties were not cleaned. Such eggs were generally broken and frozen.

Therefore, it was felt that an investigation might be profitably made of the procedures of handling that are necessary to avoid the presence of off-flavor eggs over short holding periods as well as that of inedible eggs over longer periods.

EXPERIMENTAL METHOD

TRIAL ONE

Current receipt eggs (101 cases) from an egg grading station were placed in a commercial storage house in February 1949. Each case of eggs was identified with the producer's name. Eggs from 16 producers were stored in this trial, and all eggs were less than a week old at the time of storage. The number of cases per farm varied from 3 to 15 cases. A sample of 10 dozen eggs from each producer was candled before the eggs were stored in order to pay for the eggs on a quality basis. All eggs were oil treated before storage and were held in the commercial cold storage warehouse for approximately 7 months from February 8, 1949.

Some of the eggs were removed September 8 and the remainder, September 20. At the end of the storage period all eggs were candled at the egg grading plant and were classified according to U. S. Standards for Quality of individual shell eggs. A and B quality eggs were marketed through normal commercial shell egg channels and all checks, rejects, and C eggs were broken out and the edible eggs were frozen at the time of breaking. Each check, reject and C egg was closely examined and classified as: edibles, sours, rots, crusted yolks, or spots.

TRIAL TWO

Twelve cases of eggs in seven different lots were used in this trial. Lots 1, 2, 3, and 5 each consisted of 30 dozen naturally clean eggs and 30 dozen washed eggs. Each of these lots was from a different farm. Lot 4 consisted of 29 dozen clean eggs, 11 dozen hand buffed or brushed eggs, and 8 dozen washed eggs from a 5th farm. (The odd number of dozens was due to the limited number of cleaned eggs available on this farm.) Lot 6 consisted of 30 dozen large Grade A white eggs, and Lot 7 consisted of 12 dozen large Grade A brown eggs. (Lot 7 was used to fill the case which had not been filled with

TABLE 1—*Treatment of washed eggs**

Lot No.	Temp. of water, °F.	Time in water, minutes	Detergent used	Method of loosening dirt	Method of removing dirt	Method of drying eggs	When packed
1	150	3–5	H–T–H	soaking	mechanical buffer	mechanical buffer	at once
2	114	5	Tide	soaking	rinse	with cloth	at once
3	114	**	McConnon cleanser and water softener	soaking	wash by hand	on cooling rack	when dry
4	89	10–15	none	soaking	damp cloth	on egg flat	when dry
5	Warm	3–5	Climalene	soaking	wash by hand	on cooling rack	when dry

*All farmers were asked to wash or buff their eggs as they normally did each day.
**Not measured.

Lot 4 eggs.) Lots 6 and 7 were selected at random from eggs candled at a grading station. The age and previous treatment of these eggs was not known. Lots 1, 2, 3, and 5 were eggs from White Leghorn flocks and Lot 4 consisted of eggs from a flock of Rhode Island Red hens.

Half of the eggs used in this trial (except Lots 6 and 7) were laid July 5. Soiled and dirty eggs were washed either that evening or the following morning. All eggs were taken to the grading station, candled, and oil treated on July 6. These eggs were then stored in an egg storage room at the grading station for two weeks before going to a commercial egg storage warehouse. The other half of the eggs in this trial (except Lots 6 and 7) were laid July 19. These eggs were candled, oil treated and taken to a commercial egg storage warehouse on July 20.

Thirty clean and 30 washed eggs from each lot were removed from storage for observations at the end of storage periods of approximately 3 months, 6 months, and 7 months. The remainder of the eggs were removed for observations at the end of 8 months' storage. These last eggs were candled and broken by grading station personnel under the writers' supervision.

All eggs were taken to the laboratory and allowed to warm up to approximately room temperature before candling and breaking except for the eggs observed at 8 months. These were candled before they had warmed up to room temperature.

The following observations were made on each egg observed at 3 months', 6 months', and 7 months' storage:

1. Candled grade
2. Weight in ounces
3. Visual score
4. Albumen height
5. "Haugh" Unit score
6. Unnatural odors
7. Unnatural appearance or foreign bodies

Only the candled observations and odor test were recorded on the eggs broken at 8 months. The visual score is a score determined by comparing the broken out egg with a series of photographic standards. An egg with a score of 1 represents the top quality and a score of 5 represents lowest edible quality.

The measured or "Haugh" score[2] is determined from the weight of the egg and its albumen height. These measurements applied to an alignment chart give an albumen quality score. Top quality eggs have a Haugh score of 100 or over. This measurement is a more refined measurement of albumen quality than the visual score.

DISCUSSION AND RESULTS

TRIAL ONE

As shown in Table 2, the primary economic loss due to storage was the decline in quality of edible eggs. Although 85 percent of the eggs were of A quality before storage, only 68 percent were of this quality after storage—a drop of 20 percent in A quality eggs. Percent of reject eggs increased from 1 to 3 percent.

Table 2—*Egg quality change during storage*

	Dozen eggs	Egg quality classification					
		A	B	C	Check	Reject	Stained
		Percent					
Before storage	5,442*	85	7	0	6	1	1
After storage	3,030	68	24	1	4	3	0

*Data taken from grading slips of the same 16 producers and consists of all eggs from the deliveries preceding and following February 8.

[2]Haugh, R. R. 1937. The Haugh Unit for Measuring Egg Quality. The U. S. Egg and Poultry Magazine, 43 (8): 552-555.

TABLE 3—*"Broken out" classification of candled low grade and loss eggs*

Candled classification	Total eggs	Characteristic of inedible eggs				
		Sour	Rotten	Crusted yolks	Blood spots	Mold
		Percent				
Checks	1,466	12.6	0	1.1	0	0
Rejects	948	12.6	7.8	5.4	19.6	0.6
C quality	347	13.1	0.0	0.7	0	0
Total (low grade eggs)	2,761	12.6	2.7	2.5	6.7	0.3
Total (all eggs)	36,360	0.95	0.20	0.18	0.51	0.01

Almost 13 percent of the eggs broken out for freezing were sour, 2.7 percent were rots, 2.5 percent had crusted yolks, 6.7 percent contained blood spots, and 0.3 percent showed a mold growth (Table 3). Although candling may remove the inedible eggs due to mold, blood spots, crusted yolks, and rot, there was no evidence to show that shell eggs candled as A or B quality contain no sour eggs.

TRIAL TWO

Better Candled Quality from Clean Eggs

Table 4 shows a summary of the candled quality of all eggs observed after storage. The percentage of AA and A eggs declined consistently for both clean and washed eggs throughout the storage period except in the 8-month old eggs. The increase in egg quality index (candling) at 8 months over the combined 6- and 7-month index may have been caused either by a change in personnel doing the candling and/or a difference in egg temperature at the time of candling.

TABLE 4—*Candled quality—percentages of quality grades*

Egg quality	New laid		Length of Storage Period					
			3 Months		6 and 7 Months		8 Months	
	Clean	Washed	Clean	Washed	Clean	Washed	Clean	Washed
AA	20	20	1	0	0	0	0	0
A	77	77	58	50	46	34	55	55
B	2	3	40	49	45	57	32	33
C	1	0	1	1	9	9	6	6
Other							7	6
Index of quality*	3.16	3.18	2.58	2.49	2.37	2.25	2.53	2.52

*Candling Index: AA = 4, A = 3, B = 2, C = 1.

The index of quality of the washed and clean eggs was approximately the same at the beginning of the storage period. After 3 months' storage the index of quality of the sample of washed eggs had dropped below that of clean eggs and maintained about the same spread throughout the 7 months of storage. Eight percent more of the clean eggs were A quality at 3 months, and 12 percent more were A quality at 7 months.

Clean and Washed Eggs Appear the Same When Broken Out

A summary of the broken-out quality of eggs in Trial 2 is presented in Table 5. Very little difference occurred between the clean and washed eggs. Quality as measured by the visual score appears to decline more between 6 and 7 months storage than when determined by the measured score.

The greater variation in the quality of brushed eggs is probably due to low numbers of eggs in this sample. These eggs started out with the highest index of quality and declined to the lowest quality as determined by the measured score.

Eggs from Lots 6 and 7 showed the lowest visual measurement after 7 months' storage and were the same low quality as the brushed eggs as determined by physical measurements. These eggs were several days older than all other eggs in the trial at the time of oiling; hence, they were probably of lower quality at the beginning.

Some Eggs Sour During First 3 Months of Storage

Primary emphasis in this analysis will be the relationship between the washed eggs as a group and the naturally clean eggs. A dupli-

TABLE 5—*Broken-out quality measurements*

Quality factor	Kind of eggs	New laid*	Storage period		
			3 months	6 months	7 months
Visual Score†	Clean	2.2	2.9	3.1	3.4
	Washed	2.2	2.8	3.2	3.4
	Brushed‡	2.0	3.4	3.5	3.4
	Lots 6 and 7	—	3.2	3.3	3.6
Haugh Score§	Clean	73	—	62	60
	Washed	73	—	61	61
	Brushed‡	79	—	52	55
	Lots 6 and 7	—	—	58	55

*Approximate score determined by observations of other eggs from the same farms during the same week.
†This visual score is based on photographic standards for broken out egg quality. Lowest numbers represent best egg quality.
‡Small number of eggs.
§Haugh Score is based on thickness of firm albumen, with a correction applied for weight differences. Largest numbers represent best egg quality.

TABLE 6—*The development of sour eggs*

Lot No.	Kind of eggs	Storage periods								
		3 Months			6 and 7 Months*			8 Months**		
		Size of sample	No. sour	Percent sour	Size of sample	No. sour	Percent sour	Size of sample	No. sour	Percent sour
1	Clean	30	0	—	60	0	—	259	3	1.1
	Washed	30	0	—	60	9	15.0	262	21	8.0
2	Clean	30	0	—	60	0	—	261	1	.3
	Washed	30	0	—	60	1	1.6	259	8	3.0
3	Clean	30	0	—	60	0	—	235	3	1.2
	Washed	30	0	—	60	0	—	262	4	1.5
4	Clean	30	3	10.0	60	2	3.3	250	3	1.2
	Washed	12	2	16.6	36	8	22.2	40	7	17.5
	Brushed	13	0	—	38	6	15.7	72	5	6.9
5	Clean	30	0	—	60	0	—	258	0	—
	Washed	30	0	—	60	2	3.3	261	3	1.1
6	Grade A (white)	60	0	—	120	8	6.6	509	15	2.9
7	Grade A (brown)	10	0	—	30	0	—	104	2	1.9
Total	Clean	150	3	2.0	300	2	.6	1263	10	.7
Total	Washed	132	2	1.5	276	20	7.2	1084	43	3.9
Total	Brushed	13	0	—	38	6	15.7	72	5	6.9
Total	Lots 6 and 7.	70	0	—	148	8	5.4	613	17	2.7

*Six- and Seven-month observations combined.
**These eggs were candled and broken by grading station personnel under writer's supervision.

cate trial should be run before a detailed analysis of the different washing methods is made.

Sour eggs were discovered in Lot 4 as early as 3 months after storage. Three sour eggs were found in the naturally clean eggs and two in the washed eggs at this time. After the eggs had been in storage for 7 months, sour eggs were detected in the naturally clean eggs of Lot 4 and in the washed eggs of Lots 1, 2, 4, and 5; as well as in the brushed eggs of Lot 4 and in Lot 6.

Some sour eggs were detected in all lots of washed eggs, brushed eggs and Lots 6 and 7 at the end of 8 months storage. Only one lot (5) of naturally clean eggs showed no sour eggs throughout this trial.

Table 6 shows the number of sour eggs which developed during this trial. No sour eggs were found in the clean eggs of Lot 5 and only 5 sour eggs were found in the washed eggs. More sour eggs were found in Lots 1 and 4 than in any other lot. This may have been due to the washing method, to the age of eggs when washed, or other handling practices.

TABLE 7—*The occurrence of sour eggs for all storage periods*

	Clean eggs	Washed eggs
Number of eggs	1713	1492
Number sour	15	65
Percent sour	0.9	4.3

The number of sour eggs per sample of naturally clean eggs after 8 months storage varied from 0 to 3; whereas the number of sour eggs in the washed samples varied from 3 to 21, an average of 8.4 for each sample.

The occurrence of sour eggs in the washed eggs was about 5 times as frequent as in the naturally clean eggs.

Candling Fails to Detect Sour Eggs

The problem of sour eggs in storage eggs would be greatly reduced if such eggs could be readily detected by candling. However, Table 8 shows that a majority of the sour eggs in this trial were classified as either A or B quality when candled.

Although less than 3 percent of all eggs stored became sour during storage, three-fourths of the sour eggs were candled as A and B quality and would normally have gone into consumer channels of trade.

Only 7 percent of all sour aggs were detected as inedible and the remaining 93 percent were placed in edible shell egg quality classifications.

SUMMARY

The incidence of souring in storage eggs is increased materially by washing the eggs prior to oil treating and storage. Eighty-one percent of the sour eggs found in the lots of eggs which had been either clean or washed occurred in the washed eggs.

TABLE 8—*Relationship between candled quality and occurrence of sour eggs*

Candled quality	Total eggs	Sour eggs	
		Number	Percent
A	1756	29	1.6
B	1308	44	3.4
C	210	15	7.1
Reject	20	7	35.0

Storing naturally clean eggs minimizes the risk of eggs souring, but does not eliminate it. Only one lot of clean eggs went through 8 months of storage without the development of some sour eggs. Souring occurred as early as 3 months after the eggs were stored in both washed and clean eggs.

The candled quality of the washed eggs declined slightly more than did the candled quality of clean eggs. This greater decline in quality occurred during the first 3 months of storage.

The broken-out quality of washed and clean eggs declined at the same rate throughout the 7 months' storage period.

Sour eggs are not generally detected by the candling technique. Over 90 percent of all sour eggs in this trial were classified as A, B, or C quality by candling.

Although there was a considerable variation in the numbers of sour eggs found in different lots, this study was not designed to evaluate these different washing methods, but merely to point them out. No control was exercised over temperature of eggs when washed, temperature of washing water used, or egg-cooling practices followed. These farms were selected at random, and thus indicate the variation in normally used washing practices. None of these washing practices resulted in the elimination of egg souring or in reducing this loss to the level attained by storing naturally clean eggs.

YIELDS OF PICKLING CUCUMBERS AS INFLUENCED BY RATES OF FERTILIZER APPLICATION, FERTILIZER PLACEMENT AND NITROGEN SIDE DRESSING

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Approximately 40,000 acres of pickling cucumbers are grown annually in Michigan. For many years the state has ranked first in both acreage and production. The large acreage, rather than a high yield per acre, however, has permitted Michigan to hold its rank as the leading producer of pickles. One factor responsible for low yields of pickles (60 bushels per acre in Michigan compared with 75 or more bushels in many other states, 1944-48 average) is perhaps inadequate and improper use of fertilizer. The effects of several fertilizer treatments on the yields of pickles grown at East Lansing, Croswell, and Fremont in 1947, and at East Lansing in 1948, are reported in this paper.

PROCEDURE

One fertilizer mixture (3-12-12) and rates per acre of 300, 500 and 800 pounds were used in all tests. Nitrogen side dressing consisted of a per acre application of 200 pounds of ammonium nitrate, put on when the plants began to send out runners. Planting and plot designs and methods of placement varied with location.

At East Lansing, the pickles were grown on a productive Hillsdale sandy loam. Broadcast (after plowing) and double band placements were used. In the broadcast treatments the fertilizer was spread by hand, following which the plots were harrowed and cultipacked. Band placements were applied with an Iron Age Potato Planter with the covering disks removed. The fertilizers were placed in parallel bands 4 inches apart and 2 inches from the plants, and at a depth of 4 inches. The crop was planted June 23 in 1947 and June 15 in 1948. The hill planting system was used with a 3 x 6 foot spacing in 1947 and 3 x 7 in 1948. Hills were thinned to two plants each. A randomized block

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design with triplicated 20-hill plots was set up in 1947. The 1948 design was similar except that the plots were split and 10 hills in each received the ammonium nitrate side dressing, applied with a U. S. D. A. Bureau of Plant Industry and Agricultural Engineering Special Side Dresser No. 27.

The tests at Croswell[1] were conducted on an Arenac sandy loam, a rather poorly drained soil, low in fertility, which had been in grass sod the previous five years. The broadcast treatments, both before and after plowing, were applied with a grain drill. Four openings were used for each row so that two bands of fertilizer were deposited 2 inches deep, one 3½ and the other 10½ inches on each side of the seed row. The seed were drilled June 25 in 7-foot rows. Later the plants were thinned to approximately 12 inches apart in the row. Treatment design consisted of a split-plot randomized block in which each main plot consisted of two 100-foot rows. Ammonium nitrate was applied at the rate of 200 pounds per acre by hand as a side dressing to one row of each main plot on July 15.

At Fremont[2] a fertile Isabella clay loam was selected which had received earlier in the season 10 tons of manure plus 300 pounds of a 2-12-6 fertilizer per acre. The broadcast treatments were applied with a grain drill following plowing but previous to disking and planting. Seed were sown June 21 in hills at a 4 x 7 foot spacing. A split-plot randomized block design for fertilizer treatments was used. Each plot consisted of 200 feet of row length (50 hills) and was duplicated. The plots were split on July 12, and ammonium nitrate at the rate of 200 pounds per acre was applied as a side dressing to half of each.

All plots were cultivated and hand weeded while the plants were young. Diseases and insect pests were controlled by periodic dusting. During the picking season, pickles were harvested two to three times weekly. The straight pickles were graded as four commercial sizes according to their diameters as follows: No. "1"—less than 1 inch; No. "2"—1–1⅜ inches; No. "3"—1⅜–1¾ inches; No. "4"—1¾–2 inches. Yields consisted of the total accumulative amounts of the four grades.

RESULTS AND DISCUSSION

A summary of the yield data obtained from the various fertilizer treatments is presented in Table 1. Three hundred pounds of 3-12-12

[1]Acknowledgment is extended to R. G. Switzer, formerly of Gielow and Sons, Detroit, and to J. W. Rose, Extension Specialist in Horticulture, for their assistance in setting up these plots, caring for them and taking the yield records.

[2]The assistance of Gerald Bultman, C. C. Mullet (County Agricultural Extension Agent), and the C. C. Lang Company, in obtaining the yield records on these plots, is acknowledged.

TABLE 1—*Effect of rates of application and placement of 3-12-12 fertilizer as interacted with ammonium nitrate side dressing on yield of the pickling cucumbers*, expressed in bushels per acre*

Treatments			East Lansing				Croswell			Fremont		
No.	Rate (Lb./acre)	Placement	1947	1948			1947			1947		
			No side dressing	No side dressing	Side dressed	Means (1948)	No side dressing	Side dressed	Means	No side dressing	Side dressed	Means
1	300	Bands	210	184	185	185	46	33	40	.....	.....	.....
2	500	Bands	219	258	215	237	60	59	60	.....	.....	.....
3	800	Bands	176	189	199	194	102	150	126	.....	.....	.....
4	300	Broadcast after plowing	151	154	165	160	66	130	98	240	236	238
5	500	Broadcast after plowing	182	210	145	178	75	121	98	199	210	205
6	800	Broadcast after plowing	220	171	162	167	58	117	88	246	232	239
7	300	Broadcast before plowing	.....	.....	.....	.....	23	44	34	.....	.....	.....
8	500	Broadcast before plowing	.....	.....	.....	.....	43	137	90	.....	.....	.....
9	800	Broadcast before plowing	.....	.....	.....	.....	63	201	132	.....	.....	.....
10	Controls (No fertilizer applied)		97	154	129	142	13	10	12	121	119	120
	Means		179	189	171	180	55	102	78	202	199	201
	Differences Necessary for Significance (5% Level)											
	Treatment		55			49			18			53
	Side Dressing			No Significance			7.0			No Significance		
	Treatment x Side Dressing			No Significance			21.0			No Significance		

*Side dressing treatment consisted of a band application of 200 pounds of ammonium nitrate applied early in the growing season as the first runners began to develop. Yields are expressed as 50-pound bushels of all straight pickles harvested which were less than 2 inches in diameter.

fertilizer per acre gave a significant increase above the non-fertilized plots in all cases with the exception of the broadcast application at East Lansing in 1948. When only 300 pounds of fertilizer were used, band applications both years at East Lansing gave yields superior to broadcasting. Top yields were obtained at Fremont when only 300 pounds of fertilizer were applied. However, at that location the soil was initially very fertile and had received 10 tons of manure per acre plus 300 pounds of 3-12-12 fertilizer earlier in the season. At East Lansing, the highest yields resulted with 500 pounds of 3-12-12 fertilizer applied in bands. A split application in 1948 at East Lansing (not shown in Table 1) of 300 pounds in bands and 500 pounds broadcast resulted in yields comparable to those obtained from 500 pounds as bands only. The percentages of the size grades of straight pickles and the proportions of nubbins and crooks were not significantly influenced by fertilizer treatments. Therefore, only total yields are reported. A comparison of banding and broadcasting equal amounts of fertilizer (East Lansing and Croswell) showed better early growth and production for band placements, with greater late yields for broadcasting. Side dressing with ammonium nitrate was of no benefit at East Lansing or Fremont. Actually, yields were slightly depressed by additional nitrogen.

The data at Croswell provide interesting differences in response to treatment as compared with the other tests. A highly significant increase in yield resulted from nitrogen side dressing. With one exception (300 pounds broadcast after plowing), the greatest increases from supplementary nitrogen were obtained at the higher rates of application irrespective of placement. Actually, some decreases in yield were obtained when ammonium nitrate was applied alone or in combination with low levels of 3-12-12. The results favorable to ammonium nitrate side dressing at Croswell were probably obtained because of poor drainage, low fertility, and the freshly turned-under grass sod prior to seeding.

The yields in Table 1 for East Lansing and Fremont, even on most of the non-fertilized plots, were far above the state averages. Areas selected probably had fertility levels above the average normally used for growing pickles. The fertility level of the Croswell plots was perhaps the most typical of those usually selected in Michigan for pickle production. It is possible with the plots at Croswell that the upper practical limit in fertilizer rates was not reached.

CONCLUSIONS

The data suggest that on the fairly productive soils used in these experiments band applications up to 500 pounds per acre of a 3-12-12 fertilizer will prove profitable in pickle production. On poorly drained soils of low fertility, this amount may be increased to 800 pounds broadcast and 200 pounds of ammonium nitrate added as a side dressing.

SELF-PROPELLED FERTILIZER SIDE-DRESSER

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In many fertilizer experiments part of the fertilizer is applied after the plants have attained considerable growth. For example, a common treatment in corn fertilizer experiments is to side dress the stand after it is 3 feet tall or more. In this case, as with many other crops, fertilizer placement equipment on tractors cannot do the work without causing serious injury to the stand.

In order to have a machine that would satisfactorily apply fertilizer at any stage of growth, a unit was designed that would go between the rows. A crawler-type single-track garden tractor was selected for the mobile power unit.

A rotating, top-delivery cylinder hopper was mounted on the front of the garden tractor, and was driven from the axle shaft of the driver sprocket which carried the track. Rates of application could be readily varied by the use of alternate sprockets at four points as shown in Figs. 1 and 2. The correct sprocket combination for any desired rate could be obtained by referring to the chart made up for this unit.

The discharge of the hopper was controlled by a clutch in the gear drive of the hopper. The small pinion which engages the ring gear at the bottom of the hopper was placed on a sliding sleeve. This arrangement allowed the meshing of the pinion to be controlled by a flexible shaft switch which was convenient to the operator. When the pinion was out of mesh, the hopper did not rotate and therefore no fertilizer was dispensed even though the tractor, sprockets and chains were in motion. The frame of the hopper was hinged on brackets which were bolted to the tractor so that the hopper could be tilted forward by loosening a wing nut and removing the first drive chain, as shown in Fig. 3. This was a convenient means of emptying the hopper when it was necessary to change fertilizers.

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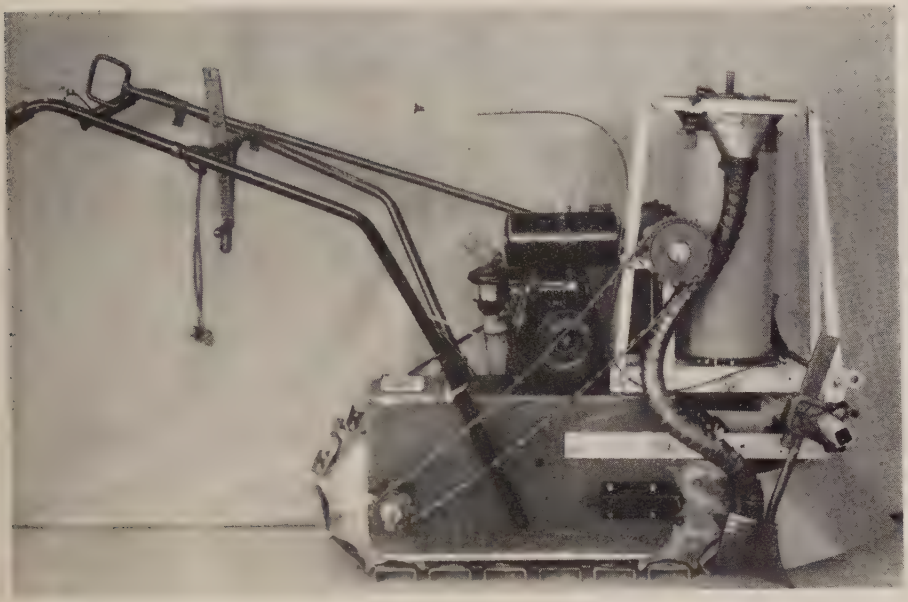

Fig. 1. Garden tractor fertilizer placement attachment. Right view, showing main drive of hopper and two points where sprockets may be changed to vary rate of application.

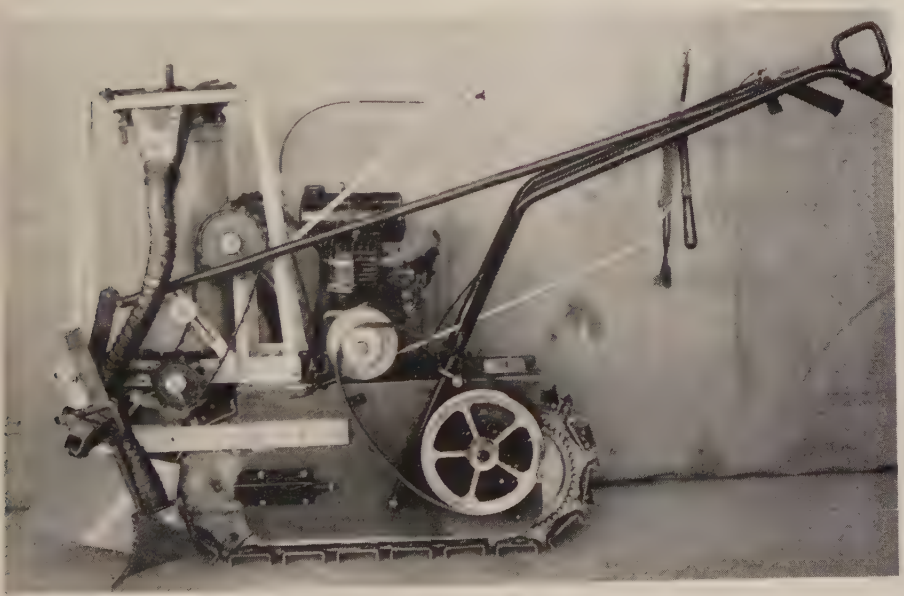

Fig. 2. Left view of the attachment. The other two sprocket changes are shown and the control of the shovels (square handle). Clutch control is the cable switch above the engine.

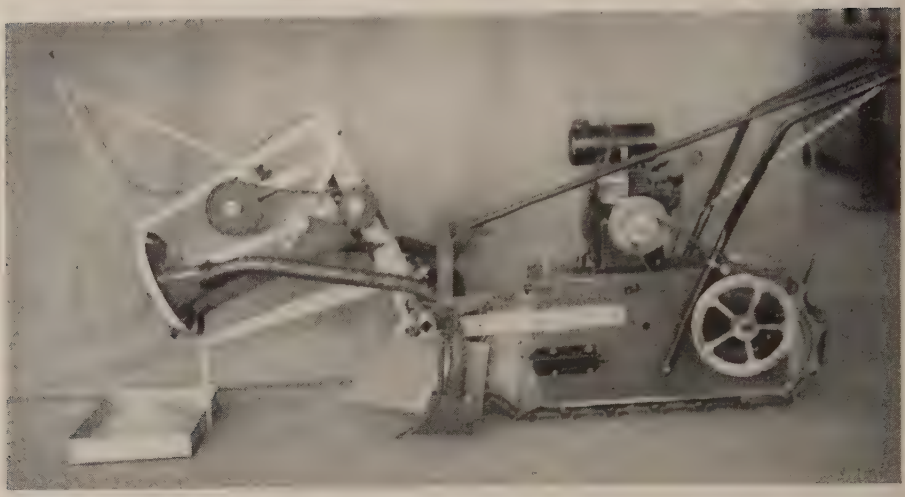

Fig. 3 Hopper is in tilted position to illustrate ease of emptying fertilizer.

The furrow openers were of the shovel type and are shown in all three figures. The openers were made by brazing two plates of 14-gage metal directly to a narrow cultivator shovel. The furrow openers were approximately one inch wide. The ribbon tubes of the hopper were attached back of the standard of each furrow opener. One tube could be used instead of two by removing one deflector plate in the top of the hopper. The tool bar clamps permitted adjustment of the shovels both vertically and laterally. After the shovels had been set for a given band placement, they could be swung in an upward position, rotating around the tool bar brackets, which allowed free operation at the ends of the plots without disturbing the soil. A lever and rock arm facilitated this motion of the shovels. The handle, lever and rock arm are shown in Fig. 2.

A vine lifter, adjustable for ground clearance, consisted of a steel frame covered with 24-gage galvanized sheet metal. This vine lifter facilitated the use of this machine in such crops as onions, which were planted in narrow rows (14 inch).

This equipment has been satisfactorily used in corn, mint, onions and celery, both on mineral and organic soils with row spacings ranging from 14 to 40 inches. The single track-type garden tractor made it possible for the machine to operate between two rows without injury to tall plants, and the track was wide enough (7 inches) to make the machine fairly stable. When stopped it would remain upright without a special rest or assistance from the operator.

A REASONABLE LENGTH OF CALVING INTERVAL

By R. C. LEWIS and R. E. HORWOOD
DEPARTMENT OF DAIRY

SEVERAL INVESTIGATIONS, among them those of Sanders (5) and Klein and Woodward (2), studying lifetime records, have shown that cows produce more milk and produce it more efficiently when they calve at approximately 12-month intervals. This plan presumes a lactation of about 10 months, followed by a 6-week to 2-month dry period. Morrow and coworkers (4), in a study of DHIA records, found the largest 305-day records were associated with 12-month lactations, followed by a 2-month dry period, making a calving interval of approximately 14 months.

Some milk pricing plans give an advantage to those dairymen who breed their cows to calve at yearly intervals. Production can then be controlled so that the maximum flow is secured during the base months.

Yearly calvings are practical in a medium-sized herd according to Wells and Horwood (6). These workers, studying a Holstein herd of 27 cows during 82 lactations, found an average calving interval of 352 days. Only six cows averaged more than 365 days between calves. It may be of interest to note that of six cows averaging more than 365 days between calves only three produced more than a pound of fat per day during their lactations, while 18 of the 21 cows with shorter calving intervals averaged over a pound of fat daily.

On many farms, however, the calving interval is often longer than 12 months. Too few dairymen keep breeding and calving records, and without these records controlled breeding is virtually impossible. Those dairymen who are also careless in observing heat periods experience further difficulty in obtaining regular calvings. A tendency to milk high-producing cows for more than 305 days, plus disease, sterility and other breeding troubles over which the herdsman has little or no control are additional factors which can lengthen the calving interval to more than 12 months. Cannon and Espe (1) who studied thousands of calving records of cows enrolled in Dairy Herd

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Improvement Associations in Iowa, found that the net result has been to lengthen the average calving interval to approximately 15 months.

The observations reported here are designed to show the results of a controlled breeding program in a large herd. Complete breeding and calving records have been kept on this herd and a conscious effort made to rebreed the cows without undue delay after calving. The herd has been Bang's accredited and relatively free from other diseases which might reduce breeding efficiency.

PROCEDURE

The breeding and calving records of the Michigan State College dairy herd at East Lansing have been analyzed for the years between July 1, 1941, and June 30, 1949. This herd is composed of representatives of the five major dairy breeds. The average length of calving interval for each breed was calculated for each year. The average length of calving interval for each breed over the entire eight years and the yearly average of all breeds were also computed. These averages were weighted according to the number of cows and are not simple arithmetical averages.

RESULTS AND DISCUSSION

A total of 365 normal calvings occurred in the herd during the eight years studied. The data are shown in Table 1. The average calving interval was 12.7 months, with a range of 12.2 to 13.4 months.

TABLE 1—*Average calving interval in the Michigan State College dairy herd*

Year	Months since previous calving					Number of calvings	Weighted average
	Ayrshire	Brown Swiss	Guernsey	Holstein	Jersey		
	Average	Average	Average	Average	Average		
July 1 to June 30							
1941-42	12.2	12.8	12.1	12.8	11.9	48	12.4
1942-43	11.6	11.8	12.5	12.5	12.1	44	12.2
1943-44	11.8	12.3	11.5	13.1	13.3	43	12.3
1944-45	12.5	15.1	12.1	12.9	13.4	37	13.1
1945-46	12.7	12.7	12.7	14.7	12.5	42	13.2
1946-47	14.7	13.8	12.2	13.3	13.3	48	13.4
1947-48	13.2	13.8	12.1	13.5	12.5	49	13.1
1948-49	12.2	12.1	12.1	13.0	11.5	54	12.3
Totals and Weighted Averages	12.6	13.0	12.1	13.2	12.6	365	12.7

Some breed differences were found. The Holstein cows averaged 13.2 months, which was significantly longer than the average of the Guernseys, Jerseys and Ayrshires. The Brown Swiss average of 13.0 months was also longer than the average of the three breeds but the difference was not statistically significant. The shortest calving interval was observed in the Guernsey herd, although it was not significantly shorter than the average of the other breeds.

Any of several factors may have caused the longer calving interval found in the Holstein herd. The average age of the Holstein cows has been greater than that of the cows of the other breeds. These older cows may not have returned to heat as quickly or as regularly as the younger cows of the other breeds. Higher average production of the Holstein cows may have had some influence on the recurrence of estrus cycles after calving. A difference in management could have caused the difference in calving interval. The higher producing cows may have been favored through delaying their rebreeding in order to encourage a higher lactation record.

That failure to conceive after being bred was not an important factor in determining the length of calving interval has been shown in a previous publication (3). The Holstein cows have required fewer services per conception under both natural and artificial breeding conditions than some of the breeds with a shorter average calving interval.

A subsequent report will consider the effects of age, level of production and management on the length of calving interval.

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THE INFLUENCE OF AGE, LEVEL OF PRODUCTION AND MANAGEMENT ON THE CALVING INTERVAL

By R. C. LEWIS and R. E. HORWOOD
DEPARTMENT OF DAIRY

A STUDY OF CALVING and breeding records of the Michigan State College Dairy herd (3) showed that the average calving interval has been longer for the Holstein breed than for the other breeds. It was suggested that the greater average age and productive level of the Holsteins or delayed breeding of the more productive animals may have been responsible for this difference. The present report deals with the results of an investigation into the effects of those factors.

MATERIALS

Records on the College herd at East Lansing, the Experiment Station herd at Chatham and the Kellogg Farm Herd at Augusta were studied to ascertain the effect of age on the calving interval. The effects of level of production and management were investigated through analyzing the records on the Holstein cows in the College herd at East Lansing.

The age effect was determined by collecting all available calving and breeding records of the three herds. The records on the East Lansing herd covered a period of approximately 18 years prior to June 30, 1948 and the Chatham and Kellogg Farm herd records extended for 15 years prior to 1941.

The records used to study the effect of production and management cover all Holstein cows that were in the herd on July 1, 1941 and those joining the herd between that date and June 30, 1949 providing they completed at least two successive normal lactations.

RESULTS AND DISCUSSION

The data regarding the relationship of age to the length of calving interval are shown in Table 1. The 1,860 normal calvings studied

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ranged from 564 first calvings to one cow that calved for the fifteenth time. So few animals calved ten or more times that these data were combined.

TABLE 1—*Effect of age on the length of calving interval*

Herd	Age at first calving	Interval before calving number								
		2	3	4	5	6	7	8	9	10 or over
		Months								
College										
Ayrshire	27.9	12.5	12.7	12.9	12.0	11.7	10.0	11.0	11.0	.....
Brown Swiss	30.5	13.1	12.8	12.5	12.9	13.5	13.6	12.6	14.2	17.3
Guernsey	28.1	13.5	12.6	13.0	12.0	13.6	12.9	12.0	14.0	13.0
Holstein	28.8	12.8	13.5	13.0	12.8	13.3	12.5	13.3	14.4	.....
Jersey	27.0	13.6	12.6	12.9	13.1	12.0	12.3	13.0	12.0	13.6
Kellogg										
Guernsey	27.6	14.1	13.2	14.5	13.8	13.7	12.4	15.0	12.3	14.2
Chatham										
Holstein	28.8	12.8	12.2	12.3	12.5	13.3	13.6	12.2	12.3	13.7
Weighted average	28.4	13.2	12.8	13.0	12.7	13.0	12.5	12.7	12.9	14.4

The heifers in these herds were bred to calve when 27.0 to 30.5 months of age. As would be expected, the Holstein and the Brown Swiss, the two latest maturing breeds, first calved when slightly older than the more rapidly maturing breeds. The average of 28.4 months for all heifers is a satisfactory record.

Little variation in length of calving interval that can be associated with age is evident from these records. The interval before the second calf was slightly longer than the following intervals. The difference, however, was not significant. The average interval increased after the ninth calving, but the number of cows having 10 or more calves was small. Practical experience has shown that abnormally long calving intervals among very old cows may be expected. These animals are usually brood cows, valued for their past high production and desirable calves. Consequently, even though breeding difficulties are more prevalent, the cows are retained for as long as possible in the hope of securing a few more calves carrying this good inheritance.

It is probably that any effect of age on the length of calving interval among younger cows has been eliminated in these data by the culling processes which, as under farm conditions, remove the difficult breeders as they appear.

TABLE 2—*Relationship between previous lactation yield and efficiency of breeding*

Butterfat production (pounds)	Number of records	Calving to first service	First service to conception
		days	days
Under 349	4	85.0	75.5
350–399	11	78.0	34.3
400–449	22	81.7	20.4
450–499	17	73.0	60.0
500–549	17	78.3	66.0
550–599	14	84.6	29.3
600–649	4	75.0	41.2
Over 650	3	77.7	77.0

Examination of Table 2 will show that the production of the previous lactation was not related to breeding results during the lactation which followed. In Table 2 the 305-day production records on the College Holstein herd were sorted according to the production of the last completed lactation. The breeding data are for the lactation which followed. The number of days from calving to first service and from first service to conception were not related to the former production.

TABLE 3—*Relationship between current production and efficiency breeding*

Butterfat production (pounds)	Number of records	Calving to first service	First service to conception
		days	days
Under 349	4	62.0	0.0
350–399	19	72.2	32.6
400–449	26	77.4	27.7
450–499	28	79.3	45.3
500–549	22	86.5	26.4
550–599	16	79.6	64.3
600–649	7	84.3	68.7
Over 650	5	80.6	76.4
Total or weighted average	127	78.9	40.0

When the records were sorted, as in Table 3, according to production of the current lactation, a tendency toward delayed rebreeding of the higher producing cows may be observed. In addition, the more productive cows do not appear to have conceived as readily as the poorer animals.

Whether the delayed rebreeding was due to failure of the high-producing cows to return to heat as quickly as the less productive animals or was due to deliberate delay in rebreeding on the part of

the herdsman cannot be stated. The failure of the better cows to conceive as readily as the others may have been due to chance, since there were not a large number of animals in any one group, or this may have been a physiological effect of the high production level. Other investigators (1) (2) have shown that high production is not necessarily antagonistic to breeding efficiency.

SUMMARY

Age had little relationship to the calving interval until after the ninth calving when the interval tended to lengthen. Production of the previous lactation was not related to breeding results of the lactation which followed. Cows beginning a lactation at a high level of production were not rebred as quickly and did not conceive as readily as those producing at lower levels.

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SIRUPS AND TOPPINGS FOR ICE CREAM

By P. S. LUCAS and W. F. ROBERTSON
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THE POPULATION of Michigan, consuming approximately 30 million gallons of ice cream annually, uses in that ice cream about 790 thousand pounds of strawberries, 575 thousand pounds of cherries, 400 thousand pounds of peaches, and 150 thousand pounds of raspberries. Toppings and fruit sirups are usually prepared by canning firms specializing in preparations specifically for use at the fountain and in the home. The use of such materials is increasing and obviously quality is enhanced when the processing is carried out close to the origin of the product, thus insuring freshness. The quantity of such fruits is further increased by the amounts used in soda fountain work, such as in toppings, sirups, and sauces. Included in this article are formulae of some of the more common and well known mixtures used by soda fountains.

Terms used for prepared fruits and sirups are rather loosely applied at soda fountains. Toppings used on sundaes are usually made from fruit, bisque, candy, nuts, and combinations of two or more of these with each other. Usually a sugar sirup is used as a vehicle for carrying the flavoring material, or the flavoring material may be included in the sirup as in the case of fudge or marshmallow topping. Sirups are saturated or nearly saturated solutions of sugar and may be flavored merely with an acid and fruit essence. Occasionally a topping may be spoken of as a sauce, depending upon the section of the country in which it is used.

Toppings and flavored sirups are customarily purchased from commercial processors catering to the fountain trade. Many dealers are equipped for production of sirups and prefer to make their own toppings especially when the fruit is in season. Many prepare and favor their own preparations of such flavor sirups as root beer, caramel, butterscotch and such. In this matter, complete control of quality is in their own hands. This is also true with regard to larger firms

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operating their own chain of stores or selling to a large number of dealers.

Procedure as given herein may need to be altered slightly, depending upon the amounts made up at any given time since conditions are changed to some extent as size of batches is altered.

FOUNTAIN SIRUPS

SIMPLE SIRUP

A simple sirup may be made by adding 10½ pounds of sugar to each gallon of water used. By adding to 55 gallons of water 578 pounds of sugar, 100 gallons of sirup will be produced. This sirup may be used as the vehicle for carrying flavors and fruit juices used, especially in the production of ice cream sodas. Amounts of sugar per gallon for simple sirups vary from 8 to 14 pounds. The heavier sirups will keep better, but have a tendency to become grainy due to crystallization. The sirup mentioned above will have a 30° Baumè reading. If heavier sirups are made, they may be diluted, by the addition of water, from their reading of 33° to 34° Baumè to the reading required, usually 30°-32°.

CHOCOLATE SIRUP NO. 1

Commercial Quantity		Small Amount
23 lb.	Cocoa	1⅛ cups
105 lb.	Sugar	2½+ lb.
8 gal.	Water	1½+ pt.
5 oz.	Benzoate of soda	¾ tsp.
¾ gal.	Glycerine	¼ cup
20 gal.	Approximate Yield	2 qt.

Dissolve benzoate of soda in 1 qt. of water, 1½ tbls. for smaller recipe. Heat cocoa, sugar, water, and benzoate of soda to 218° F. Then add glycerine. Cut one-half with simple sirup before serving.

CHOCOLATE SIRUP NO. 2

Commercial Quantity		Small Amount
19 lb.	Cocoa	1⅛ cups
110 lb.	Sugar	2¾ lb.
8 gal.	Water	1½ pt.
5 oz.	Benzoate of soda	¾ tsp.
5 oz.	Salt	¾ tsp.
5 gm.	Vanillin	dash
230 lb.	Approximate Yield	5 lb.

Mix sugar and cocoa thoroughly. Dissolve benzoate of soda in 1 qt. water, 1½ tbls. for small recipe. Heat water to boiling, add cocoa-sugar mix, and boil to 217° F. Mix vanillin in 2 qts. of water; 3 tbls. for small recipe. Cool and then add vanillin to above.

CHERRY SIRUP

Commercial Quantity		Small Amount
20 gal.	Cherry juice	1 qt.
260 lb.	Sugar	3¼ lb.
¼ lb.	Benzoate of soda powder	¼ tsp.
8 oz.	Raspberry red solution[1]	½+ tsp.
35 oz.	Strawberry red solution[2]	1 tbl.
1 lb.	Citric acid	1½ tsps.
1 gal.	Corn sirup	3¼ tbls.
52 oz.	Genuine fruit extract cherry	4¼ tsps.
80 cc.	Benzaldehyde	20 drops
40 gal.	Approximate Yield	2 qt.

Dissolve citric acid in 1 quart water, 2½ tsps. for small receipe. Dissolve benzaldehyde in ½ cup alcohol, ¼ tsp. for small recipe. Mix ingredients cold and fill into jugs.

GRAPE SIRUP

Commercial Quantity		Small Amount
10.5 gal.	Grape juice	1½ pt.
150 lb.	Sugar	2¾ lb.
4 oz.	Benzoate of soda	½ tsp.
1 gal.	Corn Sirup	⅓ cup
4 oz.	Raspberry red color[3]	½ tsp.
42 oz.	Grape true fruit extract	5 tsps.
268 lb.	Approximate Yield	5 lb.

Mix ingredients cold or heat just enough to get sugar into solution.

LEMON FLAVOR SIRUP

Commercial Quantity		Small Amount
47 gal.	Burred lemon juice	1½ cups
55 gal.	Water	1½ cups
1700 lb.	Sugar	3½ lb.
2 lb.	Benzoate of soda	38 drops
1 qt.	Yellow color[4]	40 drops
10 pt.	Oil lemon	2 tsps.
10 lb.	Gum arabic	2 tsps.
20 pt.	Water	4 tsps.
240 gal.	Approximate Yield	½ gal.

Mix lemon juice, water, sugar, yellow color, and benzoate of soda. Emulsify the oil lemon, gum arabic, and water and add to the first mixture.

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[1]Two gallons of raspberry red solution may be made by adding 1½ lb. of dry Amaranth 184 (107) and ½ tbls. of dry Indigo disulphonate to 1½ gallons of water. Dissolve and add 1½ pints of sugar color dissolved in 1 pint of water and 1 cup of 190-proof alcohol.

[2]Weigh out ½ cup Armaranth 184 (107). Add one teaspoon benzoate of soda and sufficient water to make one gallon of strawberry red solution.

[3]See note [1].

[4]Mix 1 cup each of Tartrazine 640 and Orange I 150 with ⅛ cup benzoate of soda; mix with 5 gallons of water and filter through cloth.

ROOT BEER SIRUP

Commercial Quantity		Small Amount
20 oz.	Oil sassafras	1 tsp.
9 oz.	Methyl salicylate	½ tsp.
1¼ oz.	Oil cassia (30 oz. gum arabic)	6 drops
4 oz.	Ginger Extract (60 oz. water)	20 drops
8 oz.	Tincture gentian	40 drops
340 lb.	Sugar	3 lb.
3½ gal.	Sugar color	½ cup
1 tsp.	Vanillin—pt. water	pinch
19½ gal.	Water	1½ pt.
50 gal.	Approximate Yield	2 qt.

Heat to 180°F. Cool and homogenize.

STRAWBERRY SIRUP

Commercial Quantity		Small Amount
39 gal.	Strawberry sirup 2+1	2¼ pt.
300 lb.	Sugar	2 lb.
3 pt.	Liquid red color[5]	2 tsps.
0.5 lb.	Benzoate of soda	dash
1 gal.	Strawberry true fruit extract	2 tbls.
2 gal.	Corn sirup	¼ cup
50 gal.	Approximate Yield	5 lb.

Strawberry sirup (2+1) should be 23° Baumè. Dissolve the benzoate of soda in a quart of water, ¼ tsp. water for the smaller amount. Heat to put the sugar in solution, but not over 150°F. Cool and add the corn sirup and the strawberry true fruit extract. Strawberry sirup is greatly improved by adding five gallons of blackberry sirup to 100 gallons of above.

MAPLE SIRUP FOR WALNUTS

Commercial Quantity		Small Amount
20 gal.	Water	1½ pt.
320 lb.	Sugar	3¼ lb.
4 gal.	Corn sirup	⅓ pt.
5 gal.	Glycerine	¾ cup
2 qt.	Maple extract	1¼ tbls.
27 oz.	Benzoate of soda	1½ tsps.
55-60 gal.	Approximate Yield	½ gal.

Makes up to 32° Baumè. To preserve the mixture use 0.3 of 1 percent benzoate of soda.

[5]See page 552.

PINEAPPLE SIRUP

Commercial Quantity		Small Amount
12 gal.	Pineapple juice—strained	1 qt.
162 lb.	Sugar	3½ lb.
12 oz.	Benzoate of soda	1½ tsps.
24 oz.	Fruit acid[6]	2¾ tsps.
24 gal.	Approximate Yield	½ gal.

Dissolve benzoate of soda in a little cold water. Heat only enough to get sugar dissolved, not over 180° F.

TOPPINGS

BUTTERSCOTCH SAUCE

Commercial Quantity		Small Amount
2 gal.	Water	6½ tbls.
40 lb.	Sugar	½ lb.
40 lb.	No. 11 Soft Sugar	½ lb.
80 lb.	Corn sirup	1 lb.
22 oz.	Salt	1½ tsps.
8 oz.	Tapioca flour	½ tsp.
24 oz.	Vinegar	2 tsps.
24 lb.	Sweet butter	½+ cup
16 qt.	Heavy cream	¾ cup
12 oz.	Vanilla extract	¾ tsp.
20 gal.	Approximate Yield	1 qt.

Mix water, sugar, corn sirup, and salt and bring to a boil. Mix tapioca flour in two gallons of cold water, 6½ tbls. for small quantity recipe. Add to first mixture and heat to 230° F. Add vinegar, sweet butter, and cream and heat to 226° F. Beat until cool and add vanilla extract, or add vanilla extract and homogenize.

CARAMEL FUDGE

Commercial Quantity		Small Amount
5 gal.	Water	½ pt.
20 gal.	Corn sirup	1 qt.
10 lb.	Corn starch	¼ cup
10 lb.	Butter	¼ cup
24 oz.	Gelatin	1¾ tsps.
200 lb.	Sugar	2½ lb.
2½ oz.	Sugar color	to suit
4 gm.	Vanillin	1 drop
2 gm.	Salt	pinch
50 gal.	Approximate Yield	2 qt.

Soak the gelatin ½ hr. in one gallon of warm water, ¼ cup for the small amount. Cold water is put into a kettle and the corn starch thoroughly mixed with it. Corn sirup and sugar are then added, and the batch heated. When boiling, add butter, gelatin, and color. Heat to 228° F. Cool somewhat and add the vanillin and salt. Homogenize at 2500 pounds pressure.

[6]Fruit acid may be prepared by dissolving equal parts by weight of commercial citric acid in hot water.

RASPBERRY TOPPING NO. 1

Commercial Quantity		Small Amount
45 lb.	Raspberries	1½+ lb.
93 lb.	Sugar	3⅓ lb.
2¼ lb.	Pectin	2½ tbls.
14 gal.	Approximate Yield	2 qt.

Heat to 220° F.

RASPBERRY TOPPING NO. 2

1 bbl.	Fruit (2+1)	5½ lb.
7/10 lb.	Sugar to each lb. fruit	¾ lb.
10 oz.	Raspberry red color[7]	¾ tsp.
½ lb.	Benzoate of soda	½ tsp.
2 gal.	Corn sirup	½ cup
8 oz.	Fruit acid[8]	½ tsp.
25 gal.	Approximate Yield	2 ½ pt.

Place fruit in kettle. Heat to 160° F. Allow to stand 5 to 10 minutes, heat again, with stirring, to 200° F. Let stand 1 hour, drain off juice from bottom of kettle. Weigh the balance in kettle. Either fruit or half the amount of puree may be used. Dissolve benzoate of soda in pint of water, 1¼ tsps. for small recipe. Add the sugar, color, and benzoate of soda. Heat to 180° F. Cool and add the corn sirup and fruit acid.

MARSHMALLOW TOPPING

Commercial Quantity		Small Amount
7 lb.	Sugar	¾ cup
32 lb.	Corn sirup	3¼ cups
1 oz.	Salt	¼ tsp.
10 oz.	Egg albumen (fresh)	1 tbls.
4 oz.	Vanilla extract	1+ tsp.
4 gal.	Approximate Yield	2 qt.

Heat sugar, corn sirup, and salt to 226° F. Put into beater at fast speed and slowly add egg albumen. After 2 minutes, stop and add the vanilla extract. Beat to desired weight at "fast", usually 2½ to 3 minutes.

CRUSHED PEACH TOPPING

20 No. 10 cans	Sliced peaches
100 lb.	Sugar
3 oz.	Benzoate of soda

Dissolve benzoate of soda in four ounces of water. Drain peaches and put through a ¼-inch sieve or grind. Heat to 185° F.

[7]See page 552.
[8]See page 554.

SLICED PEACH TOPPING

12 No. 10 cans Sliced peaches

Approximate Yield 12½ gallons

Drain off all juice from peaches. Place fruit in jars. Pour over peaches in each jar 6 drams solution of benzoate of soda made by adding one pound benzoate of soda to one gallon of water. Cover peaches in jar with solution made up of one quart glycerine and one quart simple sirup (34° Baumè). Rinse jars, covers and rubbers in benzoate of soda solution mentioned above.

STRAWBERRY TOPPING

Commercial Quantity		Small Amount
1 bbl.	(2+1) Strawberry fruit	5½ lb.
1 lb.	Sugar to each lb. fruit	1 lb.
8 oz.	Strawberry red color[9]	½ tsp.
½ lb.	Benzoate of soda	½ tsp.
2 gal.	Corn sirup	6½ tbls.
32 oz.	Fruit acid[10]	2½ tsps.
2 gal.	Strawberry juice (drained from fruit)	6½ tbls.
8 oz.	True fruit strawberry extract	½ tsp.
30 gal.	Approximate Yield	3 pt.

Drain juice from fruit and weigh fruit. Dissolve benzoate of soda in 1 quart of water, 2½ tsps. for small recipe. Heat fruit, sugar, strawberry red color, and benzoate of soda to 180° F. Then add corn sirup, fruit acid, strawberry juice, and fruit extract.

FRUIT SALAD TOPPING

Commercial Quantity		Small Amount
6 No. 10 cans	Crushed pineapple	2 lbs.
6 No. 10 cans	Sliced peaches	2½ lb.
1 No. 10 can	Maraschino cherries	½ lb.
30 lb.	Sugar	1½ lb.
5 oz.	Benzoate of soda (mixed with sugar)	
38 qt.	Approximate Yield	

[9]See page 552.
[10]See page 554.

A STUDY OF THE ESSENTIAL ELEMENTS OF A PEN BARN AND THEIR ACCEPTANCE BY MICHIGAN MILK SANITARIANS[1]

By B. F. CARGILL and J. S. BOYD
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FOR TWO YEARS Michigan State College, through the cooperation of the North Central Region, has been conducting experiments on the use of loose housing or pen barns for dairy cattle. As a result of this project it has been determined that there are four essential areas in a well arranged pen barn.

These four areas are:

1) A paved feeding area that has 1½ linear feet of hay self feeder and 2½ feet of silage manger per cow. It is possible to feed hay and silage in the same manger when it can be so arranged. Bedding should be used on this area if it is inside the barn and should not be used if the feeding area is located out in the barnyard.

2) A paved barnyard with an area of 60 to 75 square feet per cow. The barnyard should be on the south or east side of the barn and slope 1 inch in 4 feet away from the barn to drain water from the concrete.

3) A "lounging" area with 50 square feet per cow. This area should not provide hay, silage, or water because if any one of these items is located in the "lounging" area, traffic lanes to these items will develop. These traffic lanes are responsible for keeping an area unfit for cows to lay on.

4) A milk area that has a milking parlor and a milk house. The milking parlor should have self-closing doors to and from the pen area, smooth walls and ceiling, and should be connected to a milk house that meets ordinance specifications. A direct connection between the milk house and milking parlor is desirable. Elevated milking stalls 30 inches above the milker's alley should be used in the milking parlor with herds of more than 15 cows. The entrance to the milking parlor should be 2 feet above the level of the pen floor.

[1]Work completed under funds made available under Hope-Flannagan Regional Project RMA-N.C.3.

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Figure 1 is an area diagram showing the arrangements of the four areas with respect to each other. If an inside feeding area is provided the cows should enter this area directly from a south or east paved barnyard. At no time should the cows be allowed to cross any portion of the lounge area to get to this inside feeding area. If the cows are allowed to cross the lounge area on their way from the barnyard to the inside feeding area the following conditions will exist: 1) More

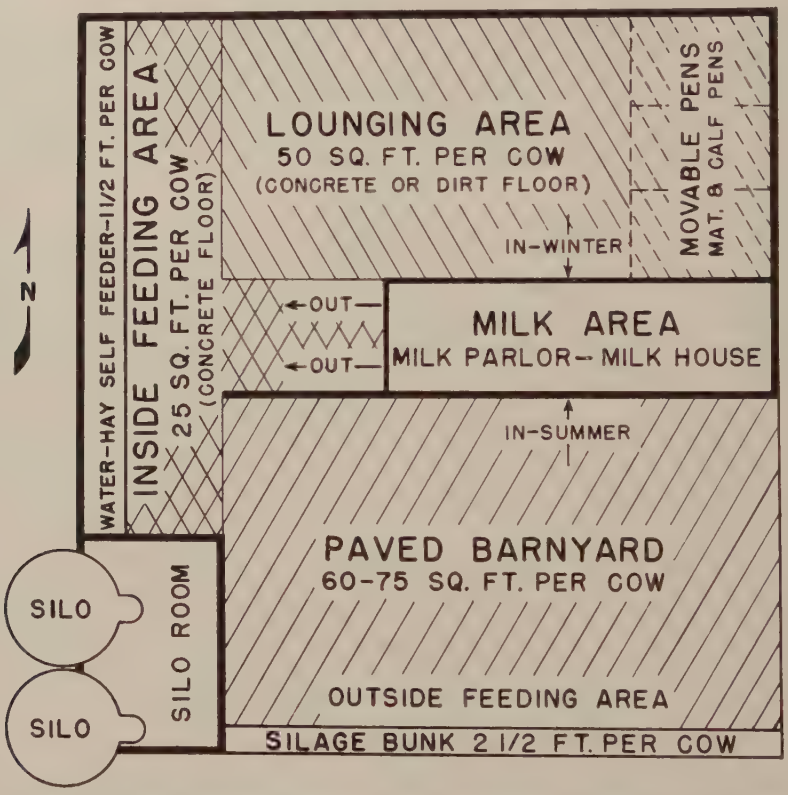

Fig. 1. Area diagram, showing the relationship of the four major areas applied to either 1-story or 2-story pen barns.

bedding will be required, 2) More frequent bedding will be necessary, 3) The lounge area cannot be kept clean, 4) The number of cows that can be housed in the barn will be reduced and the cows that are housed in the barn will become dirty, and 5) cows will not lie in traffic lanes when lounge areas are provided.

The cows should enter the milking parlor from the clean lounge area and exit onto the feeding area. With this arrangement the cows

do not track into the milking parlor an excessive amount of soiled bedding.

If the four major areas are located as shown in the area diagram then it will be possible to have clean cows with the minimum amount of bedding. Sanitary habits of the management will then determine the quality of the milk.

In order to guide the construction of pen barns, milk ordinances have been enacted and milk sanitarians are, in general, interested in ways and means of building more efficient pen barns. A survey was made of milk sanitarians, similar to that by Jefferson and Weaver (1945), to determine the inspectors' reaction to the pen barn. Questionnaires were prepared and sent to 42 city Health Departments in cities with a population of 8,500 and over. Sixty-seven percent of these questionnaires were returned and the following is a summary of the answers.

Question: *How many pen barns do you have in your milk shed?*

Eighteen city sanitarians or 64 percent, reported 1 or more pen barns in their milk shed. They reported a grand total of 325 pen barns, an average of 18 pen barns and a range of 1 to 77 pen barns per milk shed.

Question: *What is your reaction toward the farmer who needs to remodel his barn and wants a pen barn?*

Fifty-four percent of them would encourage the farmer, 25 percent remained neutral, and 21 percent reported they would discourage the farmer.

Question: *Does your city milk ordinance contain specific regulations governing pen barns?*

Sixty-four percent said they did not have specific regulations governing pen barns. The group that did not have regulations were then asked "Are regulations needed?", to which 72 percent replied they want the regulations and 28 percent indicated that specific regulations were not needed.

Question: *To the best of your knowledge, is the quality of the milk produced in a pen barn equal to, superior or inferior to the quality of the milk produced in stanchion barns when handled by men of equal ability and sanitary habits?*

Sixty-four percent reported the quality was equal to, 22 percent reported it was superior, and 14 percent reported they were not in a

position to answer this question. It was interesting to note that no one reported that milk produced in pen barns was inferior to that produced in stanchion barns.

Question: *Can the milk house be located in the dairy barn?*

Eighty-nine percent of the sanitarians indicated this would be approved, while 11 percent said "no". Of the inspectors who will allow the milk house in the barn, 64 percent require a vestibule between the milk house and milking parlor. Thirty-six percent of these inspectors do not require it. It is difficult to explain why 64 percent of the inspectors require the vestibule between the milk house and the milking parlor.

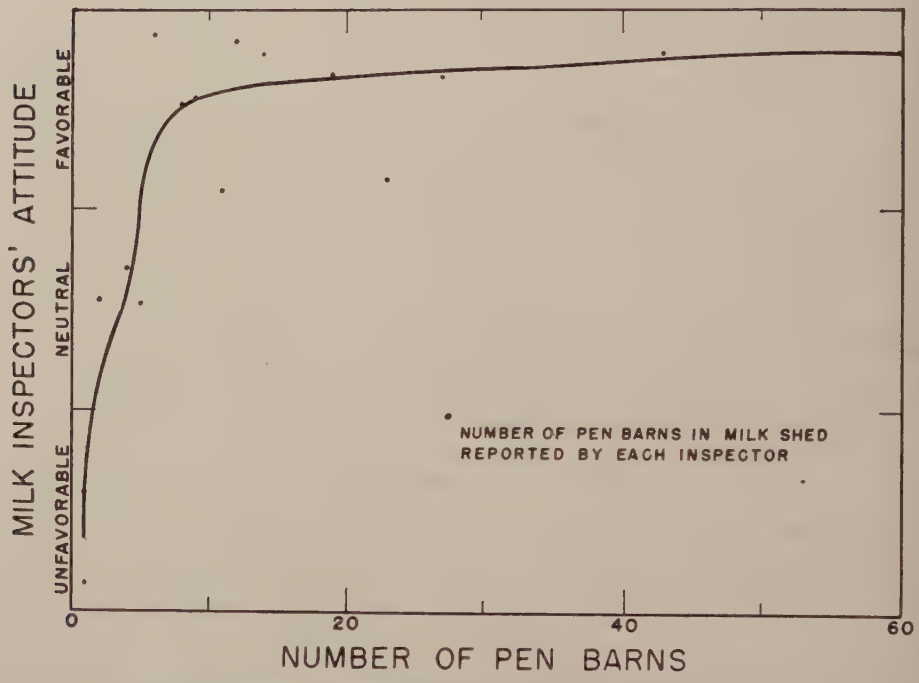

Fig. 2. The curve indicates a correlation between the number of pen barns in the milk shed and the milk inspectors' attitude towards the pen barn.

A statistical analysis of the questionnaire is shown in Fig. 2. The curve indicates that there is a correlation between the number of pen barns in the milk shed and the milk inspectors' attitude toward the pen barns. There is a tendency for the city sanitarians with only one pen barn in his milk shed to look unfavorably on pen barns, while in

the milk sheds where there is an average of 10 pen barns the tendency is to judge the barn favorably.

Regardless of the requirements, if clean milk is to be produced from clean cows the pen barn must be properly arranged and managed. It also must be properly arranged and managed if it is to be efficient, economical and successfully operated.

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CONTROL OF CELERY EARLY BLIGHT IN 1948 AND 1949

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THE MICHIGAN celery crop is subject to attack by two serious leaf diseases which, singly or together, may cause great damage in seasons favorable for their development. The optimum environmental conditions for the epidemic development of each of these diseases are so unlike that weather is likely to be favorable for at least one of them each year. The late blight disease caused by *Septoria apii* and *S. apii graveolentis,* is most active in wet, cool seasons and causes the greatest damage to the late summer or autumn crop. Early blight, caused by *Cercospora apii,* on the other hand, is most aggressive when mean temperatures are above normal and the atmospheric humidity is high. Hot, sunny days, followed by heavy dews, or occasional light showers provide the optimum temperature and moisture conditions for its epidemic development. Early blight causes the greatest injury to the summer crop and normally subsides in the fall with the advent of lower mean temperatures.

Although early blight was first noted in the United States in 1881 (1) and in Michigan in 1885 (3), it was not until 1932 that a destructive epidemic of the disease was recorded in Michigan (5). Moderate or severe outbreaks occurred in 1933, 1935 and 1938, and in those seasons early blight alone caused heavy losses in the Michigan celery crop. One of the most serious outbreaks of this disease occurred in 1949 and caused widespread and costly injury to the crop in all the major growing sections of the state. The disease appeared early and was well intrenched before growers were aware of its development. The destructive effects of early blight in 1949 emphasizes again the necessity for adequate protection of the Michigan celery crop by the application of effective dust or liquid fungicides.

No documented data on losses in the 1949 crop as a consequence of early blight are available, but the early and summer crops were

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severely damaged. Many plantings were abandoned in midsummer because they were so badly blighted that they could not be harvested and marketed with a profit. It was difficult to find fields of yellow celery effectively protected with fungicides in July and August. Growers estimated the losses from early blight in Kalamazoo county at $100,000. The state loss from the disease was in excess of $350,000.

In previous reports (6, 7, 8, 9, 10), it was shown that early blight can be controlled with dust fungicides developed in Michigan especially for the control of celery leaf diseases. In experimental work in Kalamazoo county from 1933 to 1940, various dust formulations were tested for the control of leaf diseases. From these experiments a new dust was developed that is effective in the control of celery leaf blights. The recommended formula is as follows:

Yellow cuprous oxide	6-7 pounds
Fine dusting sulfur	30 pounds
Loomkill talc	63-64 pounds

A specific diluent is recommended because the keeping quality of the dust is dependent upon the chemical nature of the carrier for the fungicidal ingredients. A highly alkaline material is required, and it was found that Loomkill talc was the most satisfactory of the several that were tested.

The cuprous oxide-sulfur dust has been used with satisfactory results by Michigan celery growers. Under average seasonal conditions it gives effective protection against both early and late blight. Under some seasonal conditions yields have not always been compatible with the degree of blight control and the dust may have caused some minor injury to the plants. Not until equally effective fungicides were developed for use on celery was it possible to determine the comparative effects of the copper-sulfur combination on yields.

Experimental work on the development of dust fungicides for the control of celery leaf diseases was resumed in 1948 following suspension of this work in 1941. The object of these experiments was to test new and promising fungicides to determine their value in comparison with the standard cuprous oxide-sulfur dust and other formulations.

METHODS

A standard, 4-row, 8-nozzle Niagara Cropmaster duster was used in the experimental work. A recent change in dusting methods in

the intensive cultural districts consists in the use of small, power dusters to replace the manually operated dusters in general use before the war. Most of these small dusters do not discharge the dust at a sufficiently high velocity to accomplish complete coverage of plant surfaces susceptible to infection by blight fungi. Complete coverage is necessary for protection against infection. Both upper and lower surfaces of the leaves must be covered with the fungicide. To accomplish coverage of the lower surface of the leaves the dust must rebound when it strikes the soil or upper leaf surfaces and deposit a coating of the protective fungicide on the under sides of the leaves. A high discharge velocity of the dust particles is required to accomplish this. In the duster used in these experiments, four of the eight nozzles were removed to increase the discharge velocity of the dust particles. When the plants were small, four rows were dusted with single nozzle coverage and two nozzles were used for each row when more dust was required to cover the larger plants.

The experimental dusting was done only in the evening. Winds during the day interfere with the efficient application of dusts. In the early morning the air is still but the plants are too wet. In the evening conditions are most favorable for dusting, and all the applications were made after 8:00 p. m.

Most of the plantings in Kalamazoo County consist of small acreages and the plants are various sizes because of spaced planting dates. Spaced plantings are made so that marketing may be continuous throughout the summer. The average planting does not provide enough rows of plants of the same age for the layout of a desirable experimental design, especially where a number of fungicides are to be compared for blight control and yield effects. It is impractical to break up these small plantings into blocks for multiple replications of the treatments since this would entail a partitioning of the rows and excessive travel in the rows with the duster and a consequent compacting of the soil. It is necessary to dust entire rows or multiple rows with a single fungicide. In these experiments two rows were dusted simultaneously with the same fungicide and a total of four rows were treated similarly. These rows were 35 rods long and the spacing between the rows was 32 inches.

Various factors influenced the rates of application of the dust mixtures. It was found that atmospheric humidity alone caused a variance as great as 30 to 40 percent in the discharge rate of a dust from the same aperture. Different densities of the various dust formu-

lations also caused a marked variation in the rate of discharge from the same nozzle. Because of these uncontrollable factors it was impossible to equalize the rates of application. Instead, the amounts of each dust used for each application were weighed. Although rates of application differed, the degree of plant coverage with each dust was comparable.

In both seasons the experimental plots were watered by overhead sprinkling lines. This practice is often conducive to the spread and epidemic development of leaf blights. The operation of the sprinkling lines in 1948 and 1949, however, was not a major factor in the development of early blight and late blight made a slight development only in 1949.

The variety of celery planted in the experimental plots in both years was Cornell 19, a yellow celery that is very susceptible to early blight. The plantings and harvesting was done by the grower and the harvest days were determined by him. Yellow celery was difficult to market in 1948 but apparently was preferred by consumers in 1949 when the supply of good quality yellow celery was not adequate to supply market demands. As a consequence of these varying market conditions, the experimental blocks of celery were harvested late in 1948 and very early in 1949. The plants were fully mature in 1948 but immature in 1949. The yields were, therefore, smaller in 1949.

A weekly inspection of the plants, as well as a final visual rating at the time of harvest, was used to evaluate the effectiveness of the various dust mixtures tested in 1948 and 1949. Together with yield records, this was judged a fair method of rating the fungicidal efficiency of each dust and its possible phytotoxicity.

Yield records were taken from a 50-foot block of representative plants traversing all of the rows in the experimental plots. Harvesting was continuous on alternate days for 2 to 3 weeks. The sampling block was harvested near the end of the harvesting period so that the maximum development of blight could occur. The treatments were randomized in the block and the yield records were obtained from duplicate blocks of 2 rows each. The dusting was done at night when the air was still; consequently, drift effects were minimized but not entirely eliminated. Inspection of the control plots showed that this factor was of little importance in the comparative development of blight in adjacent 2-row plots.

MATERIALS AND RESULTS IN 1948

Six dust formulations were compared for blight control in the 1948 trials. Each dust contained the following fungicidal ingredients in 100 pounds:

1 Dithane Z-78,—6 pounds
2 Dithane Z-78,—6 pounds, dusting sulfur 30 pounds
3 Cuprous oxide—6 pounds, dusting sulfur 30 pounds
4 Tribasic copper sulfate, 13 pounds
5 Tribasic copper sulfate, 13 pounds, dusting sulfur 30 pounds
6 Tribasic copper sulfate, 13 pounds, dusting sulfur 30 pounds, NuZ (55 percent zinc), 4 pounds.

The plants were about 4 to 6 inches tall when the dusts were first applied and only an occasional early blight lesion could be found on the basal leaves. The applications were spaced as follows: July 2, 9, 15, 21, 29; August 13, 19; September 1. Because of unfavorable weather conditions early blight made little development until late August and in September. The disease developed rapidly in September, and the undusted control rows were conspicuously blighted at the time of harvest. The blight control ratings and net yields are shown in Table 1.

TABLE 1—*Comparative control of early blight and net yields of celery in experimental plots, Cramer farm, Comstock, Michigan. 1948*

Dust fungicide	Blight control rating	Net yield, in 20-pound, flat crates*
Dithane-sulfur	1	2320
Cuprous oxide-sulfur	1	2090
Dithane	2	2150
Tribasic-sulfur-zinc	2	2120
Tribasic-sulfur	3	1800
Tribasic	4	1780
Undusted control	5	2210†

*The 20-pound flat crate is a standard container used for marketing celery in the Kalamazoo area.

†The weights of the undusted, blighted plants were comparatively high because they were set in the field 2 weeks earlier than those in the dusted plots. Only 24 rows of plants of the same age were available for experimental dusting. For the controls it was necessary to use four rows of larger plants in an adjacent planting of the same variety. The larger size of the plants and the late development of early blight were responsible for the high yields in the control rows.

Superior blight control, as determined by the extent of leaf injury was achieved with the Dithane-sulfur and Cuprous oxide-sulfur dusts. The tribasic copper sulfate-sulfur-zinc formulation was only slightly

less effective. Dithane without sulfur and the tribasic copper sulfate without zinc did not control the disease as well. The addition of sulfur to the Dithane and of zinc to the tribasic-sulfur mixtures greatly increased the fungicidal efficiencies of those dusts and also increased the yields of marketable celery. The yields in the Dithane-sulfur plots were higher than those in the other plots, but the differences among the yields of the cuprous oxide-sulfur, tribasic-sulfur-zinc and the Dithane plots were too small to be significant.

Blight lesions were numerous on every plant in the undusted rows, and the older leaves were damaged in the rows dusted with the tribasic and the tribasic-sulfur dusts. The improved control of blight by the addition of 2-percent zinc to the tribasic-sulfur formulations indicates that the zinc functioned as a fungicide. As will be shown later, the results with dusts containing zinc in 1949 indicate that the higher yields from its use can not be attributed to the metal functioning as a nutrient ion.

MATERIALS AND RESULTS IN 1949

In the 1949 trials the Dithane-sulfur, cuprous oxide-sulfur, tribasic-sulfur and the tribasic-sulfur-zinc dusts were again used. Three dust formulations with Acti-dione as the fungicidal ingredient were included for the initial trial of this antibiotic in dust form. Acti-dione is a by-product of the manufacture of Streptomycin (4) and Felber and Hamner (2) showed that it is an effective fungicide for the control of powdery mildew on beans when used at high dilutions. It has not previously been used in dust form. Preliminary greenhouse trials with a 1-percent dust prepared from the dried, carbon adsorbate of Acti-dione showed that it protected snapdragon plants against infection by rust *(Puccinia antirrhini)*. A 2-percent carbon adsorbate was used to prepare 1- and 2-percent dusts and a 2-percent dust to which 25-percent dusting sulfur was added. Acti-dione is apparently most active in acid solutions, and sulfur is a suitable amendment for maintaining an acid reaction on the leaf surface in the presence of water.

The experimental plots were located in the same field used for the 1948 trials. Early blight lesions were numerous on all plants in this field and the disease was causing severe injury to older plants in adjacent fields when the the dusts were first applied. Temperature and moisture conditions were much more favorable for the disease of 1949 and few growers were successful in checking its spread in July and August.

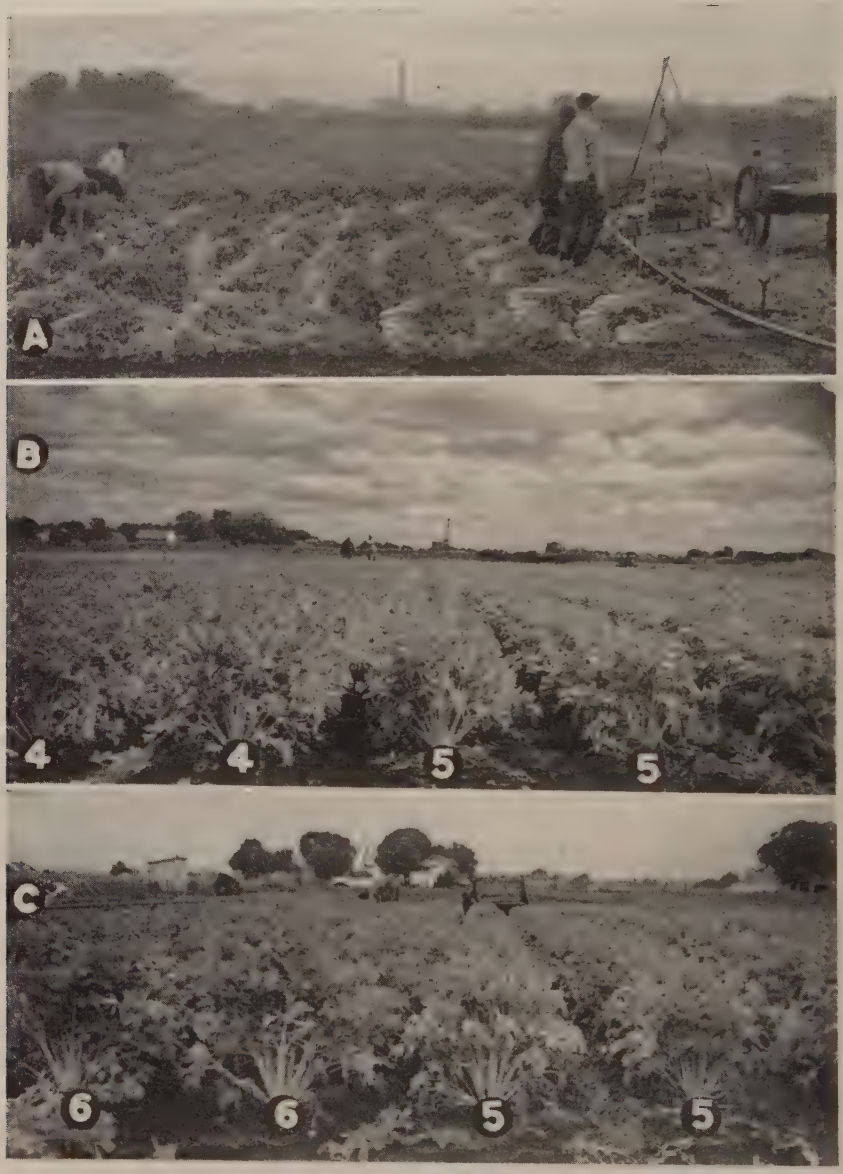

Fig. 1, A. Harvesting the yield-sampling block in the celery experimental plots, 1948. The plants were cut out of the rows, trimmed to marketable condition and weighed.

Fig. 1, B. Two rows of undusted celery, 5, in one of the control plots and 2 rows dusted with the Dithane-sulfur dust, 4. The dusted plants were much larger and the net increase from control of early blight was 45 percent higher than the yields from the control plots.

Fig. 1, C. Two undusted rows, 5, and 2 rows, 6, dusted with 1-percent Acti-dione dust. Although early blight was not well controlled by Acti-dione it apparently was stimulative to vegetative development and yields were much higher than those from the undusted plants.

Eleven applications were made on the following dates: July 11, 15, 21, 29; August 2, 8, 11, 16, 22, 25, 29. The mean quantities of each dust applied varied from 31 to 44 pounds per acre but these variations did not appear to influence the extent to which susceptible plant surfaces were covered. Leaf coverage appeared to be accomplished equally well with each of the formulations.

The dusting was continued until the quantity of celery remaining in the experimental plots was sufficient for only one week of marketing. The plots were then sampled by the same method employed in the 1948 experiments (Fig. 1, A). The blight control ratings and net yields of marketable celery are shown in Table 2.

TABLE 2—*Blight control and net yields of celery in experimental dusting plots, Cramer farm, Comstock, Michigan. 1949*

Dust fungicide	Blight control rating	Net yield, in 20-pound, flat crates	Increase over control, percent
Dithane-sulfur	1	1790	45
Tribasic-sulfur-zinc	2	1640	33
Cuprous oxide-sulfur	2	1410	15
Tribasic-sulfur	3	1680	37
Acti-dione-sulfur	4	1660	35
Acti-dione, 2-percent	5	1510	23
Acti-dione, 1-percent	6	1660	35
Undusted control	7	1230	.....

The most effective control of early blight was again obtained with the Dithane-sulfur dust. Few blight lesions appeared on the leaves after they were initially covered with this dust. The plants were much heavier and taller (Fig. 1-B, 4) than those in the other plots with the exception of those dusted with the Acti-dione formulations and were in striking contrast to the adjacent severely blighted control plants (Fig. 1-B; 5; 3-A, 5). These results were similar to those obtained in the 1948 trials.

There was little difference in the extent of blight control achieved with the tribasic-sulfur-zinc and the cuprous oxide-sulfur dusts, each of which was less effective than the Dithane-sulfur combination. The tribasic-sulfur dust was still less effective, but its fungicidal power was greatly enhanced by the addition of zinc (Fig. 3-B).

The Acti-dione formulations were inferior to the other dusts in fungicidal efficiency. Blight lesions were numerous on the leaves of all plants dusted with these formulations. The 2-percent dust containing sulfur was much more fungicidal than the other mixtures, but

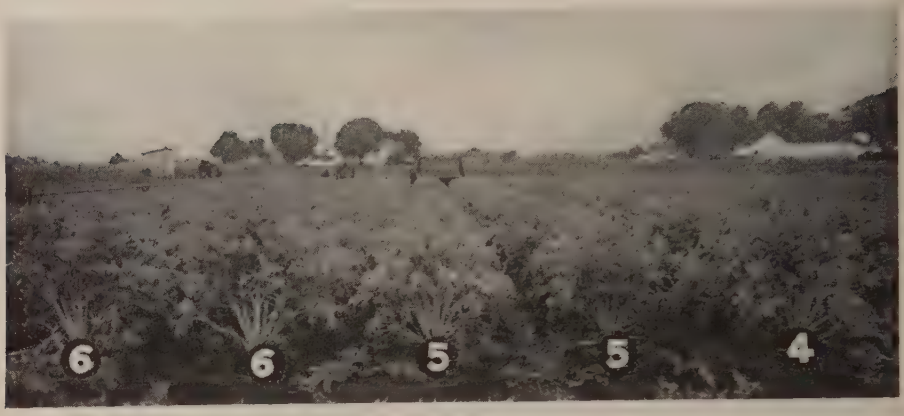

Fig. 2. Comparative growth of plants dusted with Dithane-sulfur, 4, 1-percent Acti-dione, 6, and the undusted control plants, 5, 1949. Growth was approximately equal in the rows dusted with Dithane and Acti-dione.

it controlled early blight less effectively than the four highest rated dusts. The comparatively low fungicidal index of these dusts can possibly be attributed to their small volume of fungicidal ingredient. The 1-percent dust contained only 8 ounces of the 2-percent carbon adsorbate in 100 pounds, and the 2-percent mixture contained only 1 pound. The active fungicidal particles were, therefore, few in comparison with those in dusts like tribasic mixtures which had 13 pounds of the copper fungicide in 100 pounds.

The yields from the Dithane-sulfur plots were higher than those from any of the dusted plots and were 45 percent higher than those from the undusted, control rows. The plants were larger than those from the other plots with the exception of rows dusted with Acti-dione (Fig. 2, 4). The yields from the tribasic-sulfur and the tribasic-sulfur-zinc did not differ significantly but superior blight control was evident in the rows dusted with the mixture containing zinc. This indicates, as seemed evident in the 1948 trials, that the zinc did not necessarily function as a nutrient ion and thereby stimulate increased vegetative development.

Although the yields from the cuprous oxide-sulfur plots showed a 15-percent increase over the undusted rows this was considered inconsistent with the high fungicidal efficiency of this standard dust fungicide It controlled early blight almost as well as the Dithane-sulfur dust yet the dusted plots yielded less than those protected with the tribasic-sulfur-zinc formulation which controlled early blight to a degree comparable with it. This apparent yield depression may be

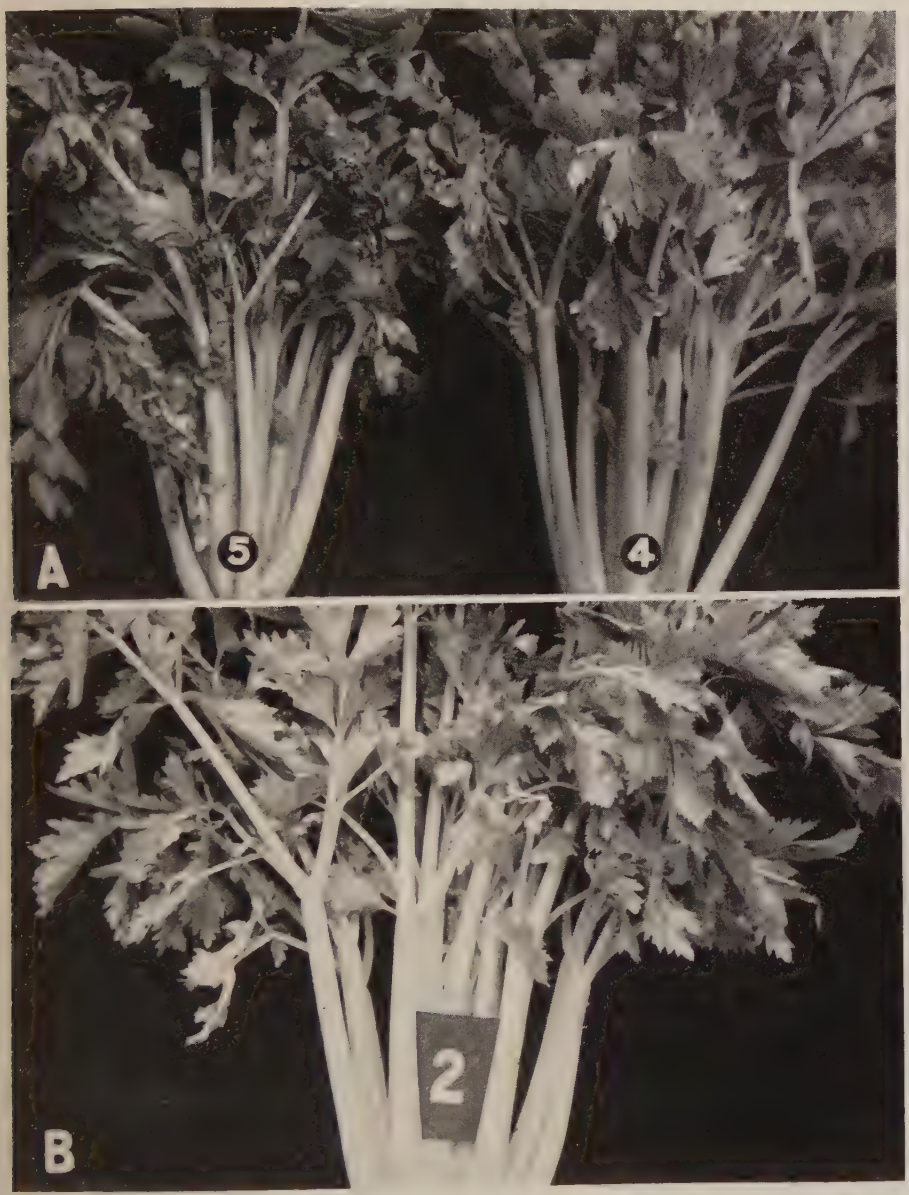

Fig. 3, A. An undusted control plant, 5, and a comparable plant from the Dithane-sulfur plots, 4. The control plants were severely blighted and could not be trimmed to a marketable grade of good quality.

Fig. 3, B. A typical plant from the rows dusted with the tribasic copper sulfate-sulfur-zinc plots. This dust gave effective control of early blight and the trimmed plants were free from blight lesions.

due to a slight phytotoxicity of this copper-sulfur mixture. Such an effect was suspected in earlier trials when yields in the dusted plots did not conform with the degree of blight control. No depression of yields apparently occurred in the plots dusted with this mixture in the 1948 trials. This indicates that phytotoxicity is influenced by seasonal conditions.

Although the fungicidal action of Acti-dione was not equal to that of the active ingredients in the other dusts, it apparently functioned as a growth stimulator (Fig. 1-C, 6). Yields from the plots dusted with the 1-percent mixture were as high as those from the plots dusted with the tribasic-sulfur and the tribasic-sulfur-zinc formulations. The plants dusted with the Acti-dione dusts, although severely blighted, were as large as those protected with the Dithane-sulfur dust and which were blight-free (Fig. 2, 6; 2, 4). Had it not been necessary to remove more leaves because of their blighted condition, the yields from the Acti-dione plots would have been the highest. Despite excessive stripping of leaves to make the plants salable, the 1-percent and the 2-percent plus sulfur mixtures increased yields 35 percent over the undusted controls (Fig. 2, 5).

DISCUSSION

Because of the high fungicidal efficiency against early blight and the higher yields obtained with the Dithane-sulfur dust for two consecutive seasons, it is recommended for trial by Michigan celery growers. It should be especially effective for protecting the summer crop which is most likely to be injured by early blight.

Since late blight did not develop in the experimental plantings either in 1948 or 1949 further work with this new dust is required to evaluate it in the control of that disease. It has already been shown that the cuprous oxide-sulfur dust controls both early and late blight (4, 5). Its use, therefore, should not be discontinued until trials show whether the Dithane-sulfur combination and the tribasic-sulfur-zinc dust control it equally well. The effectiveness of Dithane sprays in celery leaf blight control is a favorable augury for the general use of the Dithane dust on celery.

Further work is indicated with the Acti-dione dusts since this antibiotic may be a growth regulator for celery. If non-toxic and effective fungicidal dusts can be prepared from the carbon adsorbate of Acti-dione, it may be possible to obtain yields beyond those accru-

ing solely from the control of leaf diseases. As an alternative, if this can not be done, it is possible that it can be combined with effective fungicides to produce dust formulations that will be more effective in the control of leaf diseases and that will result in higher yields than those obtained with the dust fungicides now in use.

SUMMARY

Early blight caused by *Cercospora apii* was destructive in the Michigan celery crops of 1932, 1933, 1935, 1938 and 1949. The 1949 epidemic was one of the most injurious on record.

In experiments in Kalamazoo County from 1933 to 1941 many dust fungicides were compared for the control of leaf blight diseases. A cuprous oxide-sulfur dust was developed that has effectively controlled leaf diseases of celery for the past 10 years.

In experiments with new fungicides in 1948 and 1949 a Dithane Z-78-sulfur dust was more effective in the control of early blight than other dust fungicides. In addition, yields were higher in both seasons in the plots dusted with this formulation than from plants protected with other fungicides.

A tribasic copper sulfate-sulfur-zinc dust was slightly less effective in the control of blight and yields were somewhat lower in plots dusted with it than in the Dithane plots.

Acti-dione dusts were ineffective in the control of early blight but were stimulative to vegetative development of celery. Yields in the Acti-dione plots, despite serious development of early blight, were as high as those in the plots dusted with effective fungicides.

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COMMENTS ON MICHIGAN PEACH QUALITY[1]

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TWO OUT OF THREE customers are satisfied with peaches as supplied to them by growers and distributors in Michigan. "Customers", as used here includes both retailers and consumers throughout the eastern United States.

This is a conclusion indicated in an analysis of replies of 1,405 purchasers of Michigan peaches. The study is a part of a continuing study of ways of improving the marketing of Michigan peaches. The summary is from the written comments on returned postcard questionnaires which were placed in 25,000 bushels of peaches as they were packed. Since these written comments summarized here were spontaneous and not in answer to specific questions, they are in some ways more revealing than the questionnaire summary which will be reported in a later article.

TABLE 1—*Nature of comments on Michigan peaches as made by 1,405 consumers and retailers*

Nature of comment	Number of cases	Percent of cases
Very favorable	362	26
Favorable, but	372	27
Somewhat unfavorable	42	3
Very unfavorable	396	28
No comment (answered questions only)	233	16
Total	1,405	100

About as many purchasers made very favorable as very unfavorable comments (Table 1). Slightly over a fourth were classified at each extreme while another fourth were generally favorable but with

[1]Acknowledgments: The cooperation of the Coloma, Eau Claire, Millburg, Pearl Grange and Sodus Fruit Exchanges made this study possible. The author wishes to express his appreciation to them and also to Edward Powell and Vern Vandemark who did the field work on the study and to Mildred Galloway who summarized the replies.

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some reservation, for instance, "Very nice peaches, could have been a little riper but not bad". Another one-sixth of the purchasers failed to write in comments. In general, it appears that about two purchasers were satisfied with the peaches for each one who was definitely dissatisfied.

Most of the purchasers mentioned specific characteristics in the peaches that they liked or disliked. Often more than one quality was mentioned, and there was a relationship among these characteristics, as is indicated in the following comment, "Too green when purchased, then rotted in one bunch while ripening". Here the comment can be classed both as "too green" and as "rot" and as very unfavorable for both factors. In like manner, many other comments appear in more

Photo—Michigan Bell Telephone Co.

Fig. 1. These peaches have just been purchased by a first buyer. By looking at the top of a few baskets he has "guessed" how these peaches will appear when consumed perhaps 2 days or even 2 weeks later.

than one quality classification. This causes the total percentage of answers to add to more than 100 percent. There was a tendency for those who were well satisfied with the peaches to make a simple statement "Excellent", "Very good", etc. while those who were dissatisfied usually went into considerable detail. Because of this fact,

TABLE 2—*Characteristics mentioned and nature of comments concerning each characteristic made by consumers and retailers*

Comment	Nature of comment				
	Total comments		Very unfavorable	Somewhat unfavorable	Very favorable
	Number	Percent	Percent		
Ripeness (too ripe, too green, etc.)	479	34	22	11	1
Rotting or rot free	211	15	12	3	*
Waste or waste free	177	13	9	2	2
Taste, flavor, etc.	152	11	3	2	6
Bruises or bruise free	145	10	7	3	*
Pits split, diseased seeds, etc.	112	8	8	*	—
Pits cling or free	84	6	5	*	*
Size	69	5	2	1	2
Worms or worm free	60	4	2	1	1
Price	48	3	1	—	2
Topped, faced, etc.	46	3	3	—	—
Color	29	2	*	*	1
Skins tight or loose	25	2	2	—	*
Shrivel	21	1	1	—	—

*Less than 0.5 of 1 percent.

there are few "Very favorable" and many "Very unfavorable" references to particular characteristics such as ripeness and rot. These comments on specific characteristics were classed as very favorable, somewhat unfavorable to neutral and very unfavorable (Table 2).

Ripeness was the most frequently mentioned quality characteristic, with 34 percent making some comment about it (Table 2). "Too green" accounted for 32 percent of these remarks, with "mixed ripeness", "Ripe on one side, green on other side", and "too ripe" accounting for the other 1 percent unfavorable. Associated with greenness were unfavorable comments by 5 percent of the purchasers that pits cling, by 1 percent that peaches shrivel before ripening, and by 2 percent that the skins were tight.

Rot was the second most frequently mentioned characteristic, with 15 percent of the purchasers commenting unfavorably on it. One in eight commented very unfavorably regarding rot. Another 13 percent of these purchasers mentioned waste, with 11 percent of the reactions being unfavorable and 2 percent indicating that waste was small. These comments no doubt included waste from rots, bruises, worms and other causes.

Bruising was mentioned by 10 percent of the purchasers, 7 percent of whom were very dissatisfied. A few remarked on the absence of bruising.

Worminess was mentioned by 4 percent of those returning cards. Of these, one percent mentioned that the peaches were satisfactory

Photo—The Great A. & P. Tea Co.

Fig. 2. A scene at the Sodus Fruit Exchange. A major problem is the fact that this and other exchanges must handle thousands of bushels daily during the short peach harvest season.

in this respect. Where worms were present, some quite definite opinions were expressed, and in some instances the peaches were considered unfit for use.

Taste, flavor, juiciness and related factors were mentioned by one out of nine of these purchasers. This quality was mentioned favorably more often than unfavorably.

Split pits were common in the 1949 Michigan peach crop. One out of every twelve customers said his purchase was very unsatisfactory in this respect.

Peach size and color were two other qualities mentioned. In each instance there were about as many favorable as unfavorable responses.

Several purchasers volunteered the price they paid for these peaches. More than half thought that they made a good buy. In no instance where the peaches were reported as being of good quality did the purchaser think he had made a poor buy. In several cases in

which the quality was bad but the purchaser had bought the peaches cheaply, he still considered them a poor buy.

Three percent, or 46 of these purchasers, reported that the top peaches were much better than those underneath. In all these cases the comments were very unfavorable. For example, "This is the poorest basket of peaches I have ever bought. Just the top layer were nice looking". This practice is apparently not as big a factor as ripeness, rot and others but the violence of the comments where it occurs in extreme cases suggests the need for improvement.

The fact that one out of three customers was very dissatisfied with the quality of his purchase indicates that there is a fertile field for quality improvement. The problem is how to improve quality.

HOW TO IMPROVE QUALITY?

The comments on individual quality characteristics suggest the principal causes for dissatisfaction due to poor quality. They suggest that degree of ripeness was the most important cause of complaint in 1949 and fully twice as important as rot. On the other hand, rot was considered a more important defect than improper size or wormy peaches. A customer lost or disgruntled because of wormy peaches, small size, or other factors, is as important as one lost because of green peaches. The only distinction is that there apparently were fewer customers in 1949 who were bothered by those factors. To the extent that these statements of 1,172 purchasers are representative, they indicate the importance of the various quality factors, and suggest some areas in which further study is needed. For instance, on the basis of this study a 20-percent improvement in ripeness could remove as much dissatisfaction to these purchasers as the complete elimination of wormy peaches and improper sizing.

If a sizable portion of the very dissatisfied customers should cease buying Michigan peaches it could seriously affect marketing. That it has not apparently done so is no doubt due to the desire of people for peaches and the fact that peaches from competing areas face about the same marketing problems as do those from Michigan. By solving these quality problems, Michigan can gain an advantage over competing areas and promote peach marketing generally.

Picking peaches at an immature stage is due to many factors long recognized in the industry. It has generally paid the grower to err

in the direction of "too green" rather than "too ripe" when harvesting peaches. There are three major reasons for this practice:

1) It may reduce peach brown rot loss for the grower.
2) An "overripe" peach is in many cases unsalable, and peaches become "overripe" very quickly under harvesting and marketing conditions.
3) Seasonal market price movements and other economic and natural risks of leaving fruit on the tree for a few days often seem to favor immature harvest if the peaches have sufficient size for marketing.

To the extent that brown rot encourages immature harvest, this disease must be controlled if maturity problems are to be handled. Its effect on harvesting practices might conceivably be as important as its effect on waste itself. Thus brown rot may have a much greater effect on the problem of effective peach marketing than is evident from the 15 percent who complained of rot.

The utilization of "overripe" freestone peaches has not been solved to the extent that they will return as much as "green" peaches. For that reason the grower cannot afford to chance having a large portion of this type peach. More work is needed on the use of this highly perishable but high quality product.

The risk involved in letting peaches ripen are also increased by the normal seasonal price movement and by the dangers of storms or other natural forces. Normally, peach prices in the Benton Harbor area start rather high, fall for 7 to 10 days, and then rise again. For a grower selling during the period of falling prices there is an incentive to pick them even sooner than would otherwise be the case. In an earlier study at Michigan State College it was found that immature Elberta peaches were discounted slightly by buyers on the Benton Harbor market while Halehaven peaches suffered no such discount.[2] However, the normal "swell" of the peach just prior to harvest will increase the volume to be sold, so that there is little or no advantage from the early sale on this score. On the rising market after the peak movement of peaches there is actually a double gain in higher yields and higher prices.

We might ask why distributors persist in making it profitable, or at least not unprofitable, for growers to sell immature fruit? Growers

[2]Hathaway, D. E., "Causes of Differences in Peach Prices on the Benton Harbor Market", Agricultural Economics Section, Michigan Agricultural Experiment Station, East Lansing, Michigan, 1948 (Mimeo report).

are very sensitive to differential payment for peaches of different degrees of maturity or other characteristics. It would seem that distributors would reflect retailer and consumer demand more completely instead of paying almost as much for immature as for mature fruit. Apparently, they are in much the same position as the grower. "Overripe" fruit causes excessive waste and must often be greatly discounted so they too prefer to err on the side of immaturity. With more accurate and usuable standards of maturity, distributors could and no doubt would do a much better job. As it is, they must judge maturity by observing size and appearance on the basis of past experience. Often a buyer must also have a peach that can stand up under varied conditions of temperature and length of time for sale. Under those circumstances, the fact that two out of three customers are satisfied is probably as good as could be expected. Certainly, distributors realize that they cannot continue to profit from dissatisfied customers. There just is not enough readily usable information on the maturity and ripening of peaches to guide them as yet.

In conclusion, it should be pointed out again that many peaches of a satisfactory stage of maturity and ripeness were successfully marketed last year and by the same methods used for the immature peaches. It is a problem of marketing of a mature peach rather than of marketing a tree-ripe peach. It is to the interest of everyone, from the grower to the retailer, to devise methods of assuring the sale of mature peaches and of preventing the sale of immature peaches.

COSTS AND METHODS OF HARVESTING GRASS SILAGE

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FARMERS IN MICHIGAN are showing an increasing interest in grass silage as a means of utilizing part of their hay and pasture crops. Under Michigan weather conditions the possibility of having a good quality feed is better with grass silage than with the usual methods of storing the first-cutting hay. Questions are raised as to the harvesting costs and also as to the equipment and methods necessary to handle grass silage. In order to answer some of those questions, cost records of harvesting grass silage were kept on 130 farms during 1949.

TABLE 1—*Cost of harvesting a ton of grass silage*

Cost item	Hay loader and silo filler	Field chopper	
		Owned	Custom-hired
Mowing and raking	$0.63	$0.42	$0.40
Filling costs:			
Labor	1.63	.89	$2.75
Power	.90	.76	
Chopping and filling equipment	.94	.99	
Hauling equipment	.64	.28	
Total	$4.74	$3.34	$3.15

The study showed that field chopping equipment was used on 93 percent of the farms putting up grass silage. Older types of equipment such as the hay loader and stationary silo filler were used on the other farms. The average costs of harvesting a ton of grass silage with the different types of equipment are shown in Table 1. The wilting method of putting up grass silage was used by most farmers. No preservative is needed when forages are wilted to between 65-70 percent moisture before ensiling. Those who failed to ensile forage

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at the proper moisture content had poorer quality silage. Two-thirds of the farmers studied used no preservatives. Cost figures do not include any charge for preservative. If a preservative had been included, the cost would have been increased about $1.50 to $2.00 per ton of silage.

COST WITH HAY LOADER AND SILO FILLER

Since the use of stationary choppers is the older method of handling silage, the costs of using this equipment will be discussed first. The average cost of harvesting a ton of grass silage, using a hay loader and silo filler, was $4.74. This includes all the work involved from the time the grass was cut in the field until it was in the silo. The charge for labor was the largest cost item which made up over one-fourth of the total harvesting cost. That points out the major reason why farmers do not like to handle grass silage with this type of equipment. It takes a lot of time and a lot of hard work to handle the green forage. The hardest job is pitching the forage from the load into the silo filler (Fig. 1).

The usual crew for harvesting grass silage with a hay loader-silo filler consisted of three men. The men usually changed around, and one man was stationed at the silo to unload the wagons by pitching off

Fig. 1. Pitching a ton of wilted alfalfa-bromegrass forage into the silo filler required about 20 minutes of hard work.

Fig. 2. With field chopping equipment, one man can chop and load a ton of grass silage in about 10 to 15 minutes.

the loads. The other two men loaded the wagons in the field and hauled them to the silo filler. The crew of three men with two wagons and two or three tractors put from 2.5 to 3 tons of silage into the silo in an hour's time.

Farmers using the hay loader-silo filler equipment often reported difficulty in timing mowing and ensiling operations so as to get the cut forage into the silo at the proper moisture content. Frequently much of the forage was put into the silo too dry. One farmer solved this problem by having a man stay in the field while the loaded wagon was being hauled to the barn and the empty wagon was being brought back. During this time the man left in the field had the time to mow one or two swaths around the field. In this way it was possible to ensile the forage at about the proper moisture content as the wilting time was held nearly constant for all the field.

COSTS WITH FIELD CHOPPERS

Farmers who used field chopping equipment showed the lowest cost in harvesting grass silage. The average cost per ton was $3.34 or about 30 percent below the harvesting cost on farms where the hay loader-silo filler method was used. Field chopping equipment enabled farmers to chop and load forages with a minimum of hand labor (Fig. 2). A majority of the farmers employed some type of unloading

device in their wagons. As a result, the labor charge per ton of silage in unloading was only about one-half as great as where hay loaders were used and loads had to be pitched into the silo filler. Farmers with choppers had about the same charge for use of equipment as those with the hay loader and silo fillers. Apparently those farmers had sufficient use for the choppers to keep the cost low.

The cost of using field chopping equipment varied from farm to farm. Major causes resulting in variation were: 1) amount of investment, 2) hours of use in a year, and 3) the organization of the work.

EQUIPMENT INVESTMENT

Farmers' equipment investment in field choppers fell into two groups. One group had smaller type equipment with an investment of about $1,500 for the chopper and blower. The other group had what was classed as larger type equipment, with an investment of about $2,500 including the chopper and blower. The group with the smaller choppers usually had two wagons, while the group with larger choppers used three wagons. Average investment in self-unloading wagons was about $350 for each wagon. This made a total of $2,200 invested in special forage harvesting equipment for the group with the smaller choppers and $3,650 for the group with the larger choppers. In most instances, only three tractors were used by the farmers in both groups so there was little difference in the investment for power. Usually two of the tractors were owned by the farmer and one was borrowed or used in exchange with a neighbor.

HOURS OF USE

A second closely related cause of variation was the hours the equipment was used in a year's time. Unless forage harvesting equipment is used over 50 hours a year the cost of maintaining the equipment becomes excessive. Analysis of the cost records indicates that farmers should have about 75 hours of work or more before they can afford the small field chopping equipment. With the large field chopping equipment, a farmer should have not less than 125 hours as a minimum.

Keeping the foregoing data in mind, one might raise the question of how many hours a field chopper is used on any one farm. The best way to answer this question is to take an example of the normal use likely to occur on a farm of a given size. A Michigan dairy farmer with 15 to 20 cows and the usual amount of young stock would need to harvest around 75 tons of hay and about the same amount of silage.

He would also harvest 25 to 30 tons of straw. If he used field chopping equipment, it would take him about 90 hours with one of the smaller choppers. With the larger chopper it would take him only about 60 hours. Therefore, on a farm of this size the farmer could reasonably afford to own one of the smaller choppers but he would need nearly twice as much work before he could justify economically the purchase of one of the larger choppers. It should be pointed out however, that some farmers would prefer to buy the larger chopper because they can get the work done in a shorter time which sometimes means they can harvest the entire crop at a more optimum stage of maturity. Other farmers plan to do some custom work for other farmers and therefore favor the larger type of equipment.

CUSTOM WORK

The farmers included in this study had about the same harvesting cost per ton of silage with either owned or custom hired field choppers. This means that, on the average, custom rates are about in line with the cost of owning the equipment. The usual custom rates were $10.50 per hour with small equipment and $12.50 per hour with large equipment. On small farms the advantage of using the equipment can be obtained at a lower cost through custom hiring rather than owning the equipment. On larger farms there would be an advantage to owning the equipment.

ORGANIZATION OF GRASS SILAGE WORK

Another cause of variation in cost of using field chopping equipment was the organization of the work. Close coordination of men and equipment is necessary to utilize the full capacity of the equipment and keep the cost of operation as low as possible.

The harvesting of grass silage requires a different organization than in harvesting hay. In hay harvesting enough of the field is cut to keep the hauling crew busy for a day or more. With grass silage the work must be organized so that the cut forage does not become too dry before ensiling. On a good day only from 1 to 3 hours of wilting (sunshine) is required. This means that only as much forage should be cut at one time as can be hauled in the next two or three hours. Examples of good coordination of the mowing and hauling work were found on several farms. Usually enough forage was cut in the morning to keep the crew working until noon. Just before noon enough forage was cut to provide work for the first half of the afternoon. In

Fig. 3. With a mechanical unloader, one man can unload chopped forage with a minimum of hard work.

the early afternoon the forage to be hauled the last half of the afternoon was cut. Some farmers combined the mowing and raking by hooking a rake behind the mower. A better method that is gaining in popularity was the use of a windrower attached to the cutter bar of the mower. This eliminates the raking operation and reduces the amount of stones in the windrow that might cause trouble in chopping.

The most common combination of equipment and crew used was the chopper and blower, three tractors, two wagons, and 3 or 4 men depending on whether a man was in the silo at all times. When work was well organized there was little wasted time and a minimum of waiting in the field or at the barn. The chopper was considered to be the key piece of equipment, and the work was usually planned to keep the chopper going most of the time. When adequate power was available, chopped forage could be unloaded in less time than it took to load. This means that where the work goes smoothly, the load could be brought from the field, unloaded, and the empty wagon returned to the field without keeping the chopper waiting. Ordinarily a third wagon is not necessary unless the field is so far from the silo that the time spent traveling is excessive.

Many types of unloading devices were used. The type of unloader did not make much difference in the speed of unloading. The capacity

of the blower with the power available determined the unloading time. All types of unloaders required a man at the blower to keep the silage feeding in evenly without plugging.

Types of unloaders most commonly found on the farms studied were the canvas unloader and the false end gate unloader. Either type was satisfactory. The farmers with canvas unloaders reported they felt that it took less power to move the load. The farmers with false end-gates reported that they considered the low original cost and maintenance expense to be the major advantage of the false end-gate unloader. Some farmers have built special wagons with conveyors in the wagon. Most of these wagons do a good job, but their cost usually is rather high and the wagon and rack are very heavy even when not loaded. A few farmers did not have unloading wagons. These farmers found that two men could pitch the load off as fast as the blower could handle the green forage.

SUMMARY

1. Over 93 percent of the farmers included in the study used field choppers for harvesting grass silage.

2. The cost of harvesting a ton of grass silage was lower with field chopping equipment than with hay loaders and silo fillers.

3. Farmers reported that field chopping equipment not only reduced the work in harvesting but also enabled them to do it more nearly at the proper time.

4. The investment in field chopping equipment, chopper and blower, averaged $1,500 for farmers with smaller types of choppers and $2,500 for farmers with the larger types of choppers.

5. To keep the costs down to a reasonable level, a farmer should have a minimum of 75 hours of use during a year for the smaller type of choppers and 125 hours of use for the larger choppers. Field choppers were used for harvesting hay, straw, and corn silage as well as grass silage.

6. Careful organization of the work is necessary to obtain the best results with field chopping equipment both from the standpoint of saving labor and the putting up of a good quality silage.

FARMER'S EXPERIENCES WITH GRASS SILAGE

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GRASSLAND FARMING implies an emphasis on forage in the farming program. An evaluation of grassland farming necessitates a comparison of the economic aspects of different types and amounts of forage crops in a farming program. If forages, (grasses and legumes) replace cultivated crops in the farming program, they must also replace part or all of these crops in the feeding program.

Fig. 1. Michigan farmers are showing an increasing interest in grass silage as a method of utilizing forage.

One of the more recent developments in forage production is the storage and feeding of grasses and legumes in the form of grass silage. This study is an attempt to provide information which may be used for an economic evaluation of grass silage as one method of forage utilization on Michigan farms.

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This is a report of the second years' cooperative study carried on with farmers who have harvested grass silage two or more years. Approximately 400 farmers who had made grass silage in the past two years were contacted. During 1948, information on experiences in putting up and feeding grass silage was obtained from 75 farmers. During 1949, this information as well as harvesting costs was obtained from 130 farmers. Samples of grass silage from different levels of the silo were collected in 1949 from many of the farms. These samples were chemically analyzed for protein, acidity and moisture content.

KIND OF CROP HARVESTED FOR SILAGE

Forty percent of the farmers reported harvesting for silage the first cutting from new seedings. They thought this was a good way of making use of a crop often too weedy for good hay. Forty-two percent of the farmers harvested meadow-mixtures consisting of 60 percent legumes or above. Alfalfa-bromegrass mixtures were those most commonly reported. Many new seedings of alfalfa-bromegrass are mostly alfalfa, as the bromegrass does not develop much for the first year's cutting. Nine percent of the farmers reported using meadow-mixtures high in June clover. All mixtures were successfully used in making grass silage. Evidence indicates, however, that greater care is required when mixtures are ensiled with more than 50 percent alfalfa or are high in ladino clover.

CROP MATURITY AND DATE OF CUTTING

Approximately two-thirds of the farmers reported they started filling their silos with grass during the first 2 weeks in June. At the time farmers started mowing, 47 percent estimated the maturity of their crops to be at one-quarter or less blossom stage. Chemical analysis showed the early cut samples of grass silage to be higher in protein content than the other more mature samples. Protein content of grass silage was found to be markedly decreased for grasses and June and Mammoth clovers when cut at the mature stage as compared to when cut at an earlier stage of growth. Decline in protein content of alfalfa was not so great.

WILTING

In successfully making good grass silage much depends upon the moisture content of the chopped forage when it is put into the silo.

Squeeze a handful.

TO MAKE GRAB TEST:

1. Grab a medium handful of chopped forage as it comes from the chopper.

2. Squeeze the chopped forage tightly in the hand.

3. Open hand and note as below.

Moisture is about right.

ABOUT RIGHT FOR ENSILING WITHOUT PRESERVATIVE:

1. If water does not squeeze out of sample.

2. If on opening hand chopped forage remains in a roll which SLOWLY springs apart.

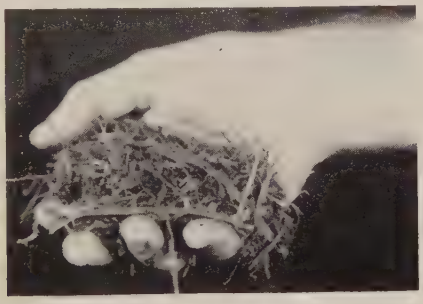
Too wet. Needs preservative.

IT'S TOO WET FOR ENSILING WITHOUT PRESERVATIVE:

1. If water squeezes out between fingers.

2. If on opening hand chopped forage is compact, and holds compressed ball-like or roll shape.

(If more than 2 or 3 loads of this too wet chopped forage has to be put into silo molasses should be added—60 to 80 pounds per ton. This does not apply to capping silo with wet chopped forage.)



Too dry. Better add water.

IT'S TOO DRY FOR ENSILING WITHOUT ADDING WATER:

1. If squeezing does not form compressed ball or roll.

2. If on opening hand chopped forage rapidly falls apart.

(Adding water will not entirely make up for moisture lost by overwilting.)

Fig. 2. Grab test used by farmers to check moisture content of chopped forage.

Most farmers putting up grass silage for the first time experienced considerable difficulty in approaching the desired level of moisture content. They usually put much of their forage up too dry, largely as a result of allowing it to wilt too long. For example, some farmers cut down too much of the forage too far in advance of the time it goes into the silo. The first portion of the field usually goes into the silo at about the right moisture content. The last portion is often too dry.

The moisture content at ensiling time should average between 65-70 percent. A need was evident for a quick and simple, yet accurate, moisture tester. The "grab test" was used by two-thirds of the farmers while 28 percent reported no moisture test used. (Fig. 2). When a farmer first makes grass silage, a moisture tester would aid him in determining the correct moisture. With more experience farmers quickly learn to know when the material has about the correct moisture content for ensiling.

The amount of wilting (time elapse between cutting and ensiling) necessary to get the crop at the proper moisture content for ensiling depends upon the kind of crop, stage of maturity and drying weather.

Fig. 3. A low-cost homemade wagon rack equipped with movable false-end gates. The load is pulled off by winding cables from the end-gate around a shaft on the end of the wagon.

Fig. 4. Field chopping equipment enables the farmer to pick up, chop, and load the forages into the wagon mechanically with a minimum amount of physical effort.

Early cut legumes such as alfalfa, sweet clover, and ladino clover for example usually require the most wilting while most grasses require little or none.

During 1949, 48 percent of the farmers reported wilting the crop from 1-2 hours (sunshine) after cutting. Sixteen percent reported ensiling their forage crop immediately allowing little or no time for wilting. Generally speaking. the success of this practice depends upon whether the crop to be ensiled contains a high percentage of grass and is cut during a period of good drying weather. When mixtures contained a high percentage of legumes, direct cutting was delayed until the legumes in the mixture were in full-blossom or quite mature. Experimental evidence indicates that if mixtures high in legumes are to be cut early and immediately ensiled without wilting, a preservative should be added.

EQUIPMENT USED

Farmers are finding that careful organization of the complete harvesting operation is necessary if forage is going to be ensiled at the

proper time from the standpoint of both maturity and moisture content. Modern machinery such as the field chopper, self-unloading wagons, and blower are largely responsible for making it possible to do the job at the proper time (Fig. 3). In addition, this equipment eliminates much of the back-breaking work formerly involved when the hay loader and silo filler were employed.

Field choppers were used on over 93 percent of the farms reporting during 1949 while the silo filler method was used on slightly over 6 percent of the farms (Fig. 4). Thirty-nine percent of the farmers hired custom-operated field choppers to fill their silos for them.

Although most of the farmers still used a rake, a more satisfactory job was performed, unless the forage was too thin, where a windrower was attached to the cutting bar of the mower (Fig. 5). The windrower, besides usually eliminating one operation, substantially reduced the number of stones found in a windrow.

PRESERVATIVES

Two-thirds of the farmers reported using no preservative while 24 percent reported using either wet or dried molasses. The remaining used grain or silo-germ and salt. Most of the farmers who applied molasses as a preservative used less than 20 pounds per ton. Experimental evidence has shown this amount to be too small to be effective.

Fig. 5. The windrower attached to the cutting bar of mower eliminates the extra job of raking and reduces number of stones in windrow.

KIND OF SILOS USED

Of the silos used to store grass silage, 73 percent were concrete, 14 percent tile, 12 percent wood, and 1 percent temporary (snow-fence) construction. Ninety percent of the silos were reported to be *relatively* airtight. Three-fourths of the farmers reported no juice leakage, while one-fourth reported some.

ACRES OF MEADOW REQUIRED TO FILL TO GIVEN HEIGHT

The average number of acres of meadow to fill different size silos to a given height were reported as follows:

Diameter	Average height filled	Average acres (one cutting)	Number of silos	Percent
10 feet x	31 feet	9	35	23.8
12 feet x	34 feet	16	67	45.6
14 feet x	35 feet	20	28	19.0
16 feet x	45 feet	37	2	1.4

Farmers reported the yield per acre would be about the same as for corn silage if all cuttings of forage (hay and pasture) were included.

QUALITY OF SILAGE

Eighty-one percent of the farmers rated their silage "good in smell", 18 percent as fair, and only 1 percent as poor. Eighty-four percent reported that their livestock liked the silage well, 15 percent fair and only 1 percent poor. Practically all of the silage was fed to dairy and beef cattle.

The presence of some moldy silage was reported by 61 percent of the farmers. Mold was most commonly reported as occurring around the sides. Twenty farmers said they had traces of mold occurring here and there throughout the silo. These farmers thought that if they had done a more careful job of ensiling, the mold would have been greatly reduced.

CAPPING OF SILOS

Information as to how the top of the silage was topped or sealed off was reported for 67 different silos. The farmers who reported no special attempt to cap their silo had spoilage of 3.3 tons, while those who capped their silo reported spoilage amounting to only 1.7 tons. The capped silos were opened up a month later than the uncapped silos. To be effective, a cap should seal the top of the ensilage in the silo. Of the capping reported, the plastic cap or 18 inches of sawdust gave the best results (Fig. 6).

Fig. 6. Plastic caps used experimentally to seal top of silage in silos this past season reduced spoilage to a minimum.

COMMENTS

The following are labeled as comments because in many instances, even under the best controlled experiments, it is difficult to ascertain the proper answer:

Grass silage greatly reduced the weather hazards in getting the first crop of hay harvested.

Cutting the meadow early for grass silage resulted in greater second growth for hay or pasture.

Grass silage as a practical year-round feed comes the nearest to approaching pasture as a feed as any other known forage feed.

Grass silage fed during the late summer and fall months supplemented dried pastures and helped maintain a high level of livestock production.

Sixty-two percent of the farmers reported being able to greatly reduce or eliminate the expensive protein supplements (oilmeals) thereby reducing milk production costs. The amount of grass silage most commonly fed per cow when this was done ranged from 30 to 80 pounds.

Forty-one percent said the feeding of grass silage was mainly responsible for increased production.

No farmers thought that livestock production had been decreased through the feeding of grass silage.

To arrive at the estimated value of grass silage as a feed, 130 farmers were asked to place a dollar value on it. Only 63 farmers replied, the average value was $11.18 per ton.

CHEMICAL ANALYSIS

Chemical analysis of 138 samples of grass silage showed the protein content on a dry-matter basis to vary from a high of 23 percent to a low of 9 percent, average being 17 percent. Meadows cut early at one-quarter to one-half blossom stage resulted in higher protein silage than those cut at a later, more mature stage. Moisture content of the grass silage ranged from a low of 32 to a high of 78 percent. The highest moisture content silages, particularly those containing mostly alfalfa and/or ladino clover, generally evidenced an unfavorable butyric acid smell. The lowest moisture samples generally had developed a tobacco or carmelized smell, indicating the loss of some nutrients but otherwise fairly well liked by the livestock. The acidity (pH) of the different samples ranged from 4 to 8; the average being 4.7. (On the pH scale a reading of 7 is neutral, lower readings denote greater acidity.) The poorest quality silages were found in samples having a pH of 5 or above, while the better silages ranged from about 4 to 4.5.

ESTIMATE OF SILO CAPACITY

In estimating weights of wilted grass silage, the regular corn silage tables may be used for silos whose diameters range from 10 feet to 16 feet, and whose height does not exceed 40 feet. For silos over 16 feet in diameter and 40 feet in height, add 10 percent more to the figures given in corn silage tables.

HOW CAN UPPER PENINSULA DAIRYMEN REDUCE COSTS?

By C. R. HOGLUND and R. W. CHRISTIAN[1]

Agricultural Economics Department
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Two important questions now are facing most upper peninsula dairymen. How far can they go in reducing costs to cope with less favorable price relationships? What practices or combination of practices will result in the most efficient production of milk?

Fig. 1. One hundred and thirty dairy farms were studied in nine counties located in three areas of the upper peninsula.

To answer the questions of what are the costs and returns, and what are the factors affecting the efficiency of dairy production, the Agricultural Economics Department of Michigan State College and the Bureau of Agricultural Economics, United States Department of Agriculture, made a study of 130 dairy farms in three areas of the upper peninsula (Fig. 1). The study covered a 12-month period from May 1, 1948 to April 30, 1949.

[1]Eugene Carter, Everett Elwood, William Lutz, Warren Vincent and Karl Wright assisted in starting and in closing the records. The following county agents assisted in this project: Lyle Abel, Fred Biekkola, Gail Bowers, William Cargo, Joseph Heirman, Arthur Markle, John Moilanen and Frank Molinare.

ARTICLE 32-74

Table 1—*Butterfat production, costs and returns in three areas of the upper peninsula, 1948-49*

Item	Area groups of counties		
	Baraga Houghton Ontonagon	Delta Dickinson Menominee	Chippewa Luce Mackinac
Number of farms	46	46	38
Number of cows per farm	13.0	16.1	12.2
Butterfat production per cow, pounds	289	320	252
Labor per cow, hours	134	106	117
Feed per cow:			
Concentrates, pounds	1,941	2,391	1,825
Hay, pounds	5,338	4,740	5,716
Silage, pounds	560	6,055	39
Root crops, pounds	354	323	116
Pasture, days	116	131	163
Total cost per pound of butterfat	$1.03	$1.05	$1.07
Total return per pound of butterfat	$1.00	$1.12	$1.20
Labor and management return per cow:			
Actual price for butterfat	$80.00	$95.00	$115.00
Uniform price of $0.95 per pound of butterfat	$80.00	$70.00	$75.00
Net return per hour of labor	$0.60	$0.89	$0.98

AREA DIFFERENCES IN PRODUCTION REQUIREMENTS, COSTS AND RETURNS

The dairy herds in the Delta-Dickinson-Menominee area were largest, required less labor per cow, and produced more butterfat per cow (Table 1). The cows in these herds were fed considerably more grain and silage and less hay than were the cows in the other two areas. The herds in the Chippewa-Luce-Mackinac area were smallest and produced fewer pounds of butterfat per cow.

The Baraga-Houghton-Ontonagon area was between the other two in size of herd and production per cow. Despite these differences in production and in some of the items of cost, the average cost of producing a pound of butterfat was practically the same in the three areas. There was a remarkable similarity in butterfat production, labor requirements, feeding practices, and cost figures in the Delta-Dickinson-Menominee area and the Detroit Milk Shed.[2]

Dairymen in the Chippewa-Luce-Mackinac area received a $35 greater return to labor and management per cow in the year of this study than did the dairymen in the Baraga-Houghton-Ontonagon area. This was due almost entirely to a 16-cent per pound price advantage. This higher price was largely the result of a greater utilization of milk for bottled purposes. The farms studied in this area included a higher proportion of dairymen selling on this market than was the situation

[2]"Dairy Costs and Returns in the Detroit Milk Shed, 1948-49", T. L. Hodge, Michigan State College, Agricultural Economics Report 454, July 1949.

TABLE 2—*Comparison of production practices, costs and returns for two groups of herds classified according to labor and management return per cow, 1948-49*

Item	30 High-return herds	30 Low-return herds
Labor and management return per cow	$168.00	$29.00
Return per hour of labor	$1.49	$0.22
Number of cows per farm	13.6	12.0
Butterfat production per cow, pounds	327	256
Labor per cow, hours	116	136
Feed per cow:		
Concentrates, pounds	2,257	1,950
Hay, pounds	4,898	5,524
Silage, pounds	2,660	1,307
Root crops, pounds	381	295
Pasture, days	141	131
Cost per pound of butterfat:		
Feed	$0.46	$0.64
Labor	0.25	0.37
Other	0.18	0.29
Total	$0.89	$1.30
Return per pound of butterfat	$1.17	$1.05

for the area as a whole. If the dairymen in all three areas had received the same price for a pound of butterfat, there would have been very little difference in these returns per cow.[3]

FARM TO FARM DIFFERENCES IN PRODUCTION EFFICIENCY

Far greater differences in production efficiency were found between farms in the same area than between areas (Table 2). A group of 30 herds, including the 10 most profitable herds in each area, averaged six times as great a return to labor and management per cow as did a group of 30, including the 10 least profitable herds in each area. These high-return herds produced 75 pounds more butterfat per cow, averaged somewhat larger in size, and required 20 hours less labor per cow. The cost of producing a pound of butterfat was almost 50 percent less on the high-return herds. Contributing to these lower costs were higher production per cow, more efficient utilization of feed and labor, and lower cow depreciation and veterinary expenses. The high-return herds averaged a 12-cent per pound price advantage over the low-return herds. This price advantage was greatest in the Chippewa-Luce-Mackinac area.

[3]For a more complete report of costs and returns by areas see Agricultural Economics Report 455, October 1949, "Dairy Costs and Returns in the Upper Peninsula of Michigan".

HIGH BUTTERFAT PRODUCTION ESSENTIAL FOR EFFICIENT PRODUCTION

A low-producing cow, regardless of how well she is cared for, seldom puts dollars in the farmer's pocket. It requires most of the returns from a cow producing less than 200 pounds of butterfat to pay for her food, housing, veterinary and other expenses, leaving little or no return for labor and management.

The highest producing one-third of the herds in the study produced 113 pounds more butterfat per cow and netted their owners more than twice the returns for each hour spent on them than the lowest one-third of the herds (Table 3). Size of herd was not an important factor in attaining this higher production.

Many dairymen could increase butterfat production per cow through adoption of improved breeding, testing, disease control and feeding practices. A larger proportion of the farmers who had high-producing herds were actively engaged in testing and other types of herd improvement work.

GOOD FEEDING PRACTICES ARE IMPORTANT

Feed is a major dairy cost and makes up half of the total cost of producing butterfat. In producing a pound of butterfat the cost of feed on individual farms ranged from a low of 34 cents to a high of 87 cents. It cost most upper peninsula dairymen from 45 to 65 cents per pound (Fig. 2).

Why do feed costs average twice as much for some farmers as for others? Of primary importance in keeping feed costs, as well as other per-unit costs, low is a reasonably high-producing ability of the cow.

Table 3—*Relation of butterfat production per cow and costs and returns for three levels of production, 130 farms in the upper peninsula, 1948-49*

Item	Level of butterfat production per cow		
	Lowest one-third of herds	Middle one-third of herds	Highest one-third of herds
Butterfat production per cow, pounds	232	290	345
Average number of cows per farm	13.1	13.8	13.9
Labor per cow, hours	121	111	121
Costs per pound of butterfat	$1.19	$1.05	$0.96
Returns per pound of butterfat	$1.09	$1.10	$1.10
Returns per hour of labor	$0.48	$0.82	$1.09
Labor and management return:			
Per cow	$58.00	$92.00	$132.00
Per herd	$752.00	$1,268.00	$1,960.00

No matter how well the cow of low-producing ability is fed, she does not have the inherent capacity to convert feed to milk on an efficient basis. The most efficient dairymen were able to keep feed costs per pound of butterfat low by feeding their cows according to their producing ability. Many of these dairymen also kept feed costs low by providing their cows with adequate quantities of high quality legume pasture and hay.

A study of feeding practices and costs of producing butterfat on three dairy farms illustrates variations in the efficiency in the use of feed. Butterfat production per cow averaged over 400 pounds on two of the farms and somewhat over 300 pounds on the third farm (Table 4). Cows on farm A were fed very efficiently. The cows on farm B were overfed, and those on farm C underfed for the most profitable production.

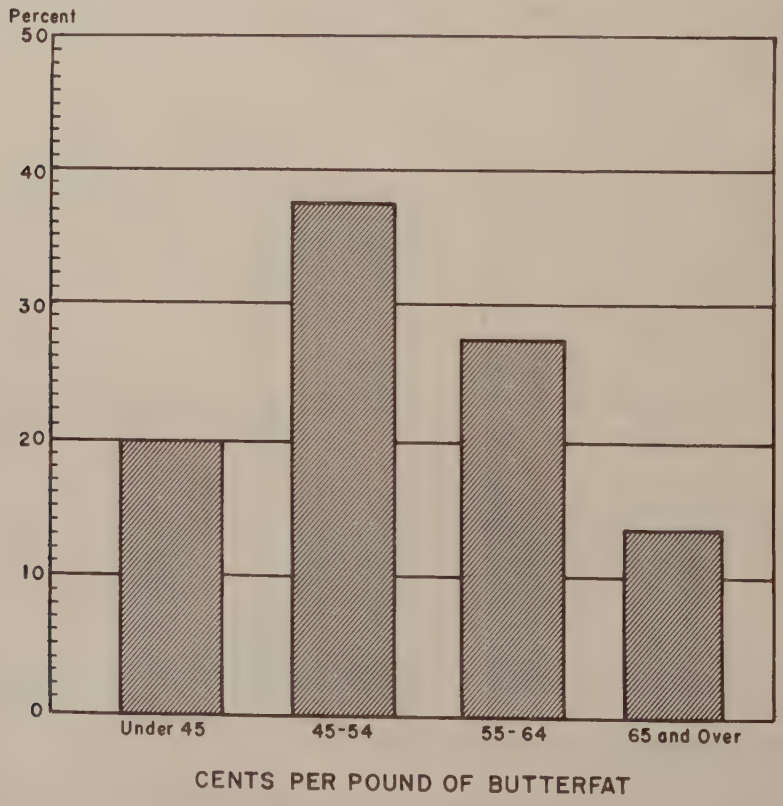

Fig. 2. Percentage distribution of farms by feed cost in producing a pound of butterfat.

Table 4—*Factors of production efficiency, costs and returns in three upper peninsula dairy farms, 1948-49*

Item	Farm A Cows efficiently fed	Farm B Cows overfed	Farm C Cows underfed
Pounds of butterfat per cow	441	410	313
Number of cows per farm	18	24	17
Hours of labor per cow	89	85	88
Percent fall and winter freshening	72	63	68
Labor and management return per cow	$208.00	$53.00	$83.00
Feed cost per pound of butterfat	0.45	0.67	0.56
Total cost per pound of butterfat	0.75	1.09	0.97
Returns per pound of butterfat	1.08	1.08	1.10
Feed per cow:			
Concentrates, pounds	2,219	4,305	998
Hay, pounds	5,475	5,720	4,725
Silage and roots, pounds	7,045	8,565	6,225
Pasture, days	137	127	168

Feed cost in producing an average of 441 pounds of butterfat per cow on farm A was only 45 cents per pound. It cost farmer B 67 cents for a 410-pound average and farmer C 56 cents for a 313-pound average. These differences in cost were due chiefly to greater inputs of farm grains, protein supplement and silage on farm B and much smaller inputs of grain on farm C. A 10-day longer pasture period, accompanied by improved pasture management practices, helped to lower feed costs on farm A compared with farm B. Although farmer C had a 30-day longer pasture period than farmer A, income could undoubtedly have been increased by barn feeding grain and roughages during this period. Returns to labor and management per cow on farm A were four times those on farm B, and two and a half times those on farm C.

An analysis of the daily rates of feeding on these three farms provides some clues as to why costs and returns were so different (Table 5). Farm A had a well-adjusted feeding program. During the pasture period, the cows on farm A were fed a daily average of 3.9 pounds

Table 5—*Daily rates of feeding during the pasture and barn feeding periods on three upper peninsula dairy farms, 1948-49*

Item	Farm A	Farm B	Farm C
Concentrates			
Barn period, pounds	7.4	11.6	3.3
Pasture period, pounds	3.9	12.2	1.6
Ratio of grain fed per pound of 4% fat-corrected milk	1:5	1:2.4	1:9
Hay			
Pasture period, pounds	4.1	6.3	1.1
Barn period, pounds	21.5	20.7	21.6
Silage			
Pasture period, pounds	9.4	7.2	3.2
Barn period, pounds	25.2	32.1	27.3

concentrates per cow compared to 12.2 pounds for farm B and only 1.6 for farm C. Another important difference in the concentrate feeding practices on these three farms was the amount of protein supplement fed. Almost one-third of the concentrate mixture used on farm B consisted of costly, high-protein supplement. The concentrate mixture averaged about 16-percent protein on farms A and C and 20 percent on farm B.

Recent experimental work in dairy cattle feeding carried out by the Michigan Agricultural Experiment Station indicates the possibility of reducing costs by substituting high quality legume roughage for part or all of the protein supplement. During the barn feeding period, cows on all three farms were fed about the same quantity of hay, with the cows on farm B receiving considerably more grain and silage.

Farmer B illustrates the economic effect of overfeeding of concentrates. He obtained a high butterfat production per cow by a costly feeding program. Based on feeding experiments carried out by 10 Agricultural Experiment Stations in cooperation with the United States Department of Agriculture, this farmer would have increased net returns by at least $40 per cow by feeding on the basis of a medium level, rather than on the basis of the heavy level of grain feeding.[4] It is estimated that this change in feeding practices would have resulted in a 2,000-pound saving in concentrates fed per cow and only 30 pounds reduction in butterfat production per cow. Feed costs could have been reduced still further by improving and lengthening the pasture period.

Farmer C illustrates the economic effects of underfeeding of concentrates. It is estimated that butterfat production per cow could have been increased by 57 pounds and net returns by $17 by feeding on the basis of 1 pound of grain to every 4, rather than to every 9 pounds of milk produced.

LARGE HERDS NECESSARY FOR SATISFACTORY FARM EARNINGS

It is difficult for the dairyman with a small herd to attain efficiency in the use of building, equipment and labor. A more important reason for increasing the size of herd is to provide a satisfactory level of farm earnings. About one-half of the dairy farms in the upper peninsula have less than 10 cows.

[4]Input-Output Relationships in Milk Production, Einar Jensen, *et al.* U.S.D.A. Technical Bulletin No. 815, May 1942.

The 130 herds were sorted into three size groups with an equal number of herds in each group. The one-third of the herds which were largest averaged almost two and a half times as many cows and netted almost three times as great a labor and management return as did the one-third of the herds which were smallest. A third more labor was used to care for a cow in the smaller herds. Butterfat production per cow averaged about the same.

The dairymen with the largest herds enjoyed a 9 cent per pound butterfat price advantage over the dairymen with the smallest herds. This price advantage, which averaged 19 cents in the Chippewa-Luce-Mackinac area and 11 cents in the Baraga-Houghton-Ontonagon area, was due to better markets. There was no difference in the price received per pound of butterfat produced in small, medium and large herds in the Delta-Dickinson-Menominee area. If all dairymen had received the same price per pound of butterfat produced, the returns to labor and management per cow would have been about the same for small, medium and large size of herds in all three areas (Table 6).

Table 6—*Relation of size of herd and costs and returns on 130 farms in the upper peninsula, 1948-49*

Item	Size of herd		
	Smallest one-third of herds	Middle one-third of herds	Largest one-third of herds
Average number of cows per farm	8.5	12.9	20.3
Butterfat production per cow, pounds	288	287	293
Labor per cow, hours	138	128	104
Costs per pound of butterfat	$1.11	$1.07	$1.01
Returns per pound of butterfat	$1.07	$1.11	$1.16
Returns per hour of labor	$0.61	$0.72	$1.01
Labor and management return			
Per cow	$85.00	$91.00	$101.00
Per herd	$721.00	$1,208.00	$2,032.00

Many dairy farmers in the upper peninsula can increase their size of herd by clearing more land, by adopting improved pasture and forage production practices, by adding labor-saving equipment, and by making improvements in barn arrangements and chore routine.

Some dairy farmers may find it difficult to increase dairy cow numbers because of the lack of barn space or acreage to produce additional pasture and roughage. However, these dairymen have some of the same advantages as the dairymen with large herds in reducing costs. Dairymen generally, regardless of size of operations, can lower production costs by the adoption of improved crop production, feeding and breeding practices.

JOURNAL ARTICLE ABSTRACTS

Some Observations on the Efficiency of Di-Phenthane-70 in Canine Teniasis

Brinker, W. O., and Platt, J.

M.S.C. Vet. 4 (3 and 4): 57-58. 1946 [Journal Article 833 from the Michigan Agricultural Experiment Station]

Since helminthiasis is an ever present problem in small animals Di-Phenthane-70 was studied both experimentally and clinically to further verify the observations reported. A total of 71 dogs were used experimentally, 10 as controls, and the remaining 61 were dosed with Di-Phenthane-70 on the basis of 8 grains per 6 pounds of body weight. All of the 61 dogs treated were found to be negative for tapeworms; 11 were infected with whipworms, and 6 with ascarids. Of the 300 clinical cases of teniasis treated only a small number had to be retreated.

From the foregoing data, it would appear that as a teniacide the drug is efficient. It was also found to be well tolerated and non-toxic at the dosage given.

Bisphenols for the Control of Cecal Coccidiosis

Hawkins, P. A., and Dunlap, J. S.

Poultry Sci. 28: 818-20. 1949 [Journal Article 1001 from the Michigan Agricultural Experiment Station]

Three new compounds, 4,4'-isopropylidenebis-2-isopropylphenol, 4,4' ethylamylidenediphenol and 4,4'-isopropyldenedi-ocresol have been shown to offer significant protection against severe infections with *Eimeria tenella*, the cause of cecal coccidiosis in chickens. These compounds were given at a level of 0.3 percent in the feed, beginning two days before infection.

The Influence of Atmospheric Gases on the Multiplication of Brucella

Sanders, Evelyn, and Huddleson, I. F.

Am. Jour. Vet. Res. 11: 70-75. 1950 [Journal Article 1013 from the Michigan Agricultural Experiment Station]

Results from the study of the influence of atmospheric gases on the multiplication of the three species of Brucella in liquid culture media show conclusively that controlled atmospheres are equally as important as the media constituents. Rates of multiplication and cell counts are greatly increased when these organisms are grown in an atmosphere of pure oxygen.

A practical liquid medium is described which, when exposed to pure oxygen and constantly agitated, produces large live cell populations of a pure growth phase of the Brucella.

The Influence of Oxygen on the Metabolic Activities of Brucella

Sanders, E., and Huddleson, I. F.

Am. Jour. Vet. Res. 11: 75-83. 1950 [Journal Article 1014 from the Michigan Agricultural Experiment Station]

The metabolism of glucose by all species of *Brucella*, when grown as described, is a rapid oxidation of the carbohydrate. The major end-product is carbon dioxide.

More glucose was decomposed per unit number of cells by all species when pure oxygen was supplied than when the medium was exposed to stagnant air. *Brucella suis* decomposed less glucose per unit number of cells than did the other two species.

Ammonia evolution was most rapid from cultures of *Br. suis* in all media. A sparing action of glucose for peptone was noted for all species but was much less pronounced for *Br. suis*. The pH changes that occur in media during the growth of *Brucella* emphasize the unreliability of any method of determining carbohydrate utilization that depends on detection of acidity.

The rates or reactions of the enzyme systems of *Brucella* accounts for the differences of the three species in the decomposition and metabolism of peptone, glucose, pyruvate, and lactate.

The Amnio Acid Content of Fresh and Stored Shell Eggs. III. Methionine, Cystine, and Lysine Contents of Eggs from Hens Fed Diets Differing in Percentage of These Amino Acids

Evans, R. J., Davidson, J. A., and Butts, H. A.

Poultry Sci. 29 (1): 104-108. 1950 [Journal Article 1027 from the Michigan Agricultural Experiment Station]

Laying hens were fed a diet that had no animal protein in it and which contained soybean oil meal as the source of supplementary protein. The percentages of lysine, methionine, and cystine in the albumen or yolk proteins from the eggs laid by these hens were no different when either commercial solvent process soybean oil meal or a drastically autoclaved meal was included in the hen's diet or when lysine and methionine were added to the autoclaved meal. There was some indication that eggs from hens fed the autoclaved meal contained fewer milligrams per egg of lysine, methionine, and cystine than eggs of hens fed the unautoclaved meal or the autoclaved meal supplemented with methionine.

Studies in Sheep Parasites. IX. The Development of Naturally Acquired Coccidial Infections in Lambs

Dunlap, J. S., Hawkins, P. A., and Nelson, R. H.

Ann. of the N. Y. Acad. Sci. 52: 505-11. 1949 [Journal Article 1037 from the Michigan Agricultural Experiment Station]

Lambs become infected with coccidia, and act as "multipliers" of the infection, passing increasing numbers of oocysts until they reached their peaks of discharge in from one to four weeks after their first appearance. A relative immunity is shown by the ewes in that they consistently passed only a few oocysts even though the number in the bedding in the barn was greatly increased by the passage of large numbers of oocysts by the lambs. The bedding is the source of infection for the lambs, the bedding being infected by the residual infection maintained in the ewes.

The natural infections which were encountered in the course of this study were of a mixed nature, with *Eimeria arloingi* and *E. Parva* being encountered most frequently.

In the small number of lambs studied there was a correlation between the time of the first oocyst discharge and the height of the peak reached. The lamb which passed the first oocysts had a lower peak than did the succeeding lambs. This was also true of the second lamb that passed oocysts, its peak being lower than the succeeding lambs, but higher than the lamb preceding.

Influence of Various Factors on the Bacteriostatic and Bactericidal Action of Streptomycin on Salmonella pullorum

CHANG, K., AND STAFSETH, H. J.

Poultry Sci. 29 (1): 130-138. 1950 [Journal Article 1040 from the Michigan Agricultural Experiment Station]

Streptomycin showed bactericidal action against *S. pullorum* in a concentration of 0.031 mg. per ml. of tryptose broth medium. The older the culture and the smaller the inoculum, the higher was the bactericidal titer of streptomycin. Streptomycin showed the highest bactericidal activity at pH 6.9 and 8.0. On the acid side, the lower the pH value of the medium, the lower was the bactericidal activity. Glucose decreased and sucrose, lactose and mannite increased the antibacterial activity of streptomycin, mannite showing the greatest activity in this respect. Vitimin C decreased the antibacterial activity of streptomycin. Sodium thiosulfate in 20 mg. quantities did not alter the antibacterial activity of streptomycin, but when 10 mg. was added the activity was enhanced considerably. Crystal violet greatly increased the antibacterial activity of streptomycin, while brilliant green showed very little effect in spite of the fact that the brillaint green shows considerably greater inhibitory effect on the growth of *S. pullorum* than does crystal violet when used alone. Sodium sulfadiazine enhanced the bactericidal activity of streptomycin. The antibacterial activity of streptomycin in serum from streptomycin-treated birds lasted about 3 hours after intramuscular injection of the antibiotic. The activity was lost gradually.

Influence of Serum of Normal and Pullorum-Infected Birds on the Bacteriostatic and Bactericidal Action of Sulfadiazine on Salmonella pullorum

CHANG, K., AND STAFSETH, H. J.

Poultry Sci. 29 (1): 139-145. 1950 [Journal Article 1041 from the Michigan Agricultural Experiment Station]

Sodium sulfadiazine showed bacteriostatic activity against *S. pullorum*. Normal chicken serum possessed bacteriostatic action against *S. pullorum* and greatly enhanced the antibacterial activity of sulfadiazine. No such properties were observed in normal rabbit serum. These bacteriostatic and enhancing activities of normal chicken serum were diminished by heating at 56° C. for 30 minutes, and were only slightly reduced by storage in the refrigerator for 25 hours. Serum from artificially infected birds showed no bacteriostatic activity. The addition of sulfadiazine to the serum in a concentration below its bacteriostatic titer caused bacteriostasis. When normal chicken serum was added to certain dilutions of serum of infected birds, the mixture became bacteriostatic but not bactericidal; when sulfadiazine was added to a mixture of normal chicken serum and certain

dilutions of serum of infected birds, a bactericidal effect was produced. In the dilutions employed none of these agents was bacteriostatic when used alone. Injected normal chicken serum failed to produce enhancing action on sulfadiazine in the body of infected birds.

Apparent Home Range of Microtus in Relation to Distance Between Traps

Hayne, D. W.

Jour. Mammalogy 31 (1): 26-39. 1950 [Journal Article 1048 from the Michigan Agricultural Experiment Station]

The home range, or the area over which an animal normally travels, has been studied by numerous investigators, some of whom have attempted to measure the extent of the home range. This paper records a series of nine measurements of apparent home range of the meadow vole *(Microtus pennsylvanicus)* in Michigan. Two methods of computing area are used. The study is based upon useful records of 153 adult animals by the first method (boundary strip) and 85 adults by the second method (minimum area). Apparent home range was observed to vary with distance used between traps. The conclusion is drawn that the commonly-used method of live trapping with a grid of traps does not necessarily measure the true home range of a mammal.

Variations in Body Weight and Organ: Body-Weight Ratios of Inbred Lines of White Leghorn Chickens in Relation to Mortality, Especially Lymphomatosis

Oakberg, E. F., and Lucas, A. M.

Growth 13: 319-337. 1949 [Journal Article 1053 (n.s.) from the Michigan Agricultural Experiment Station]

Body, liver, pancreas, and spleen weights were taken for 380 normal 600-day-old hens representing 13 inbred lines. Comparison of organ weights and organ: body-weight ratios indicated that genetically determined growth factors could be divided into those which affect the organism as a whole, those which are specific for liver and pancreas, and those which are specific for the spleen. Variation in incidence of deaths from lymphomatosis and from "other causes" was great between lines, and in some cases between families within lines. In eight lines a correlation of incidence of lymphomatosis mortality and "other deaths" was demonstrated; in three lines this relationship was not observed. Positive correlations of incidence of mortality from lymphomatosis with liver: and pancreas: body-weight ratios were interpreted as due to common factors which result both in large pancreas and liver and in susceptibility to lymphomatosis.

Penicillin Ointment in the Treatment of Conjuctivitis in Dogs

Hsuing, G., Eads, F. E., and Stafseth, H. J.

Cornell Vet. 40 (1): 4-10. 1950 [Journal Article 1057 from the Michigan Agricultural Experiment Station]

Calcium penicillin ointment was found to be highly bacteriostatic to organisms found in either serous or mucopurulent discharge from the conjunctivae. No visible signs of irritation or toxicity were observed even when the ointment was applied once daily for 11 consecutive days. Application of the ointment once daily was satisfactory.

The Application of Spray Chemicals in Concentrate Form under Michigan Conditions, Using a Conventional Speed Sprayer

MITCHELL, A. E.

Ag. Eng. 20 (11): 533-534. 1949 [Journal Article 1061 from the Michigan Agricultural Experiment Station]

In 1948 spray applications of 2x concentration were compared with the dilute form to determine the effectiveness of 2x spray concentrations for the control of apple scab and codling moth injury under Michigan conditions. Two blocks of large, bearing Red Delicious and Northern Spy apples trees were selected for this study, and all spray applications were made with a Model 29 Speed Sprayer. There was no significant difference in the amount of apple scab and codling moth injury present on the harvested fruit of the two spray treatments in the Red Delicious block. However, in the Northern Spy block there was 18.9 percent apple scab on the harvested fruit receiving the concentrate treatment and only 7.0 percent apple scab on the fruit receiving the dilute spray. Codling moth injury on the harvested Northern Spy apples was 9.6 percent for the 2x spray treatments and 8.0 percent for the dilute spray treatment. The reason for the large amount of apple scab on the harvested fruit from the Northern Spy plot sprayed with the 2x concentration was that 4 of the 10 trees in this treatment were not pruned in 1948 and the tops of these trees were beyond the effective operating limits of the Model 29 Speed Sprayer.

Further Studies of Pantothenic Acid Deficiency in Weanling Pigs

LUECKE, R. W., MCMILLEN, W. N., AND THORP, F.

Jour. An. Sci. 9 (1): 78-82. 1950 [Journal Article 1067 from the Michigan Agricultural Experiment Station]

Pantothenic acid deficiency in pigs was produced experimentally by feeding a low-protein ration containing corn and soybean oil meal supplemented with thiamine, riboflavin, nicotinic acid and pyridoxine. When, however, the unsupplemented corn-soybean ration was fed, no symptoms of locomotor incoordination were produced in the ten-week experimental period. The growth rates of the pigs in the unsupplemented lot, however, were very poor.

The results of the experiment indicate that the daily requirement of the pig for pantothenic acid is considerably above that stated by the National Research Council.

Further Observations on the Immunizing Value of Brucella M Vaccine Against Brucellosis

HUDDLESON, I. F.

Jour. Am. Vet. Med. Assn. 116 (874): 50-51. 1950 [Journal Article 1068 from the Michigan Agricultural Experiment Station]

Previous published results obtained with Brucella M-vaccine are reviewed, and the results of vaccinating animals in four herds of cattle in which unvaccinated animals were left as controls are discussed.

Uptake of Radioactive Iodine by the Thyroids of Underfed Rats

MEITES, JOSEPH, AND WOLTERINK, L. F.

Science 3 (2877): 175-176. 1950 [Journal Article 1071 from the Michigan Agricultural Experiment Station]

The quantitative relationship between degree of starvation and thyroid activity was determined in five groups of 10 rats each. These animals were placed on *ad libitum*, ¾, ½, ¼ and no-feed regimens for a 2-week period, and were each given an injection of a tracer dose of radioactive iodine (I^{131}) the day before sacrifice. The results show a direct relationship between the body weights of the starved rats and the amounts of I^{131} taken up by their thyroids. In other words, I^{131} uptake was reduced in the starved rats only in proportion to their reduced body weight. On the basis of 100 grams body weight, the amount of I^{131} taken up per thyroid was similar in all the five groups.

Form and Composition of Cherry Fruits (Prunus avium and P. cerasus) Following Fall Applications of 2,4-Dichlorophenoxyacetic Acid and Naphthalene Acetic Acid

TUKEY, H. B., AND HAMNER, C. L.

Proc. Amer. Soc. Hort. Sci 54: 95-101. 1949 [Journal Article 1090 from the Michigan Agricultural Experiment Station]

An application of a mixture of naphthalene acetic acid and 2,4-dichlorophenoxyacetic acid made to sweet and sour cherry trees on October 17, resulted in:

1. Characteristic curvatures of foliage and delayed abscission the same season.
2. Injury to twigs, buds and spurs.
3. Delayed blossoming the following spring.
4. Persistence of the "shucks" (toral tube) and delayed abscissions of abortive flowers and abortive fruits.
5. Elongate fruit with pointed apices.
6. Enlarged receptacle.
7. Strong vascular development within both the fruit and the pedicel.
8. Strong adherence of the pedicel to the fruit.
9. Adherence of the flesh to the pit and immaturity of the flesh near the pit.
10. Lighter color of fruit and delay in maturity.
11. Change in chemical composition of fruit, notably increase in moisture content and titratable acidity and reduction in sugar content.

Whether the responses were the result of naphthalene acetic acid or 2,4-dichlorophenoxyacetic acid alone or in combination, or both, is not known.

Wheels of Nutrition: A Method of Demonstrating Nutrient-Element Balance

KENWORTHY, A. L.

Proc. Amer. Soc. Hort. Sci. 54: 47-52. 1949 [Journal Article 1102 from the Michigan Agricultural Experiment Station]

A method of demonstrating nutient-element balance is described in which the various nutrient-elements are considered to be the various spokes of a wheel. The wheel is made up of as many spokes as desired, with each spoke representing

different nutrient-elements. The various nutrient-elements are considered to be in balance with each other when the spokes are of approximately equal length. Intensity of balance is described as different sized wheels.

The length of a nutrient-element spoke is calculated by computing the percent relationship of a given value to the selected standard or optimum value. The method has been used to show the influence of various cultural practices upon nutrient-element balance as measured by leaf analysis.

A chart is described that shows the various ranges in composition that may occur between deficiency and "toxicity". Also, the construction of the wood model used with this method is described.

What Has Happened to the Agricultural Ladder?

BARLOWE, R., AND TIMMONS, J. F.

Jour. Farm Economics 32 (1): 30-47. 1950 [Journal Article 1104 from the Michigan Agricultural Experiment Station]

The original concept of the agricultural ladder applied specifically to the process the young farmer goes through as he acquires experience and farming capital and as he climbs from status as an unpaid family laborer on the home farm, a farm wage hand, and/or a tenant to ownership. In popular usage this concept has often been stretched to the often unwarranted assumption that the great bulk of the men in the farming population can or should acquire farm ownership during their lifetimes.

Analysis of census data and special data collected in recent national and regional studies of farm ownership indicate that the agricultural ladder still operates very much as it did before 1920. These data show that the ladder is used to a greater extent in the Midwest than in other regions and that young farmers climb the ladder somewhat faster during periods of prosperity than during depressions. Comparison of the present data with similar data collected around 1920 shows that a larger proportion of the owners now benefit from various types of family assistance in their climb to ownership. In this sense, youth projects, father-son arrangements, and intra-family farm transfers are providing a new ladder that operates within the framework of the family.

Exploratory Experiments on the Use of Acti-dione for the Control of Peach Brown Rot and Cherry Leaf Spot

PETERSEN, D., AND CATION, D.

Plant Disease Reporter 34 (1): 5-6. 1950 [Journal Article 1109 from the Michigan Agricultural Experiment Station]

Under conditions of heavy inoculum, acti-dione was not so effective as sulfur for control of brown rot. Acti-dione at concentrations of 2 to 20 ppm. severely cracked firm ripe Halehaven fruits. No value was demonstrated for acti-dione as a fruit dip. For cherries, acti-dione appeared to have exceptional eradicative action on the leaf spot fungus *(Coccomyces hiemalis)* without injury to foliage. The material was not used when fruit was present on the tree.

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